MISSION-AREA GUIDE TO LEAD-EXPOSURE CONTROL

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Martin Marietta Corporation.

For additional information, please contact:

Army Environmental Policy Institute
430 10th Street, NW
Suite S-206
Atlanta, GA 30318-5768
Phone: 404-892-3099
Fax: 404-892-9381

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Abbreviations and Terms

Section I
Abbreviations

AA	atomic absorption
ABLES	Adult Blood Lead Epidemiology and Surveillance Program
ACOE	Army Communities of Excellence
ACSIM	Assistant Chief of Staff for Installation Management
AEC	Army Environmental Center
AEPI	Army Environmental Policy Institute
AIHA	American Industrial Hygiene Association
AIRS	Aerometric Information Retrieval System
AMC	U.S. Army Materiel Command
AR	Army Regulation
ARL	Army Research Laboratory
ARNG	Army National Guard
ATSC	Army Training Support Center
ATSDR	Agency for Toxic Substances and Disease Registry
BLL	blood lead level
BRAC	base realignment and closure
BRS	Biennial Reporting System
CDC	Center for Disease Control
CE-CPW	Corp of Engineers-Center for Public Works
CFR	Code of Federal Register
CIM	Corporate Information Management
CJC	civilian job code
CONUS	continental United States
COSIS	care of supplies in storage
DA	Department of the Army
DA PAM	Department of the Army Pamphlet
DCSLOG	Deputy Chief of Staff for Logistics
DOD	Department of De fens e
DOE	Department of Energy
DPW	Department of Public Works
DRMO	Defense Reutilization and Marketing Office

ECAS	Environmental Compliance Assessment System
EDF	Environmental Defense Fund
EDSC	U.S. Army Engineering and Housing Support Center
EO	Executive Order
EPA	U.S. Environmental Protection Agency
FBI	Federal Bureau of Investigation
FORSCOM	U.S. Army Forces Command
FR	Federal Register
GMV	general mechanical ventilation
GOCO	government-owned, contractor-operated
GSA	General Services Administration
HEPA	high efficiency particulate air
HHIM	Health Hazard Information Module
HMTA	Hazardous Material Transportation Act
HQDA	Headquarters, Department of the Army
HSC	U.S. Army Health Services Command
HUD	Housing and Urban Development
INSCOM	U.S. Army Intelligence and Security Command
JEM	job exposure matrix
LBP	lead-based paint
LEV	local exhaust ventilation
MACOM	major Army command
MCL	maximum contaminant level
MEDCEN	medical center
MEDCOM	U.S. Army Medical Command
MHE	material handling equipment
MHP	Minnesota Healthcare Partners
MILSPEC	military specification
MIM	Medical Information Module
MOS	Military Traffic Management Command
µg/dl	micrograms per deciliter
$\mu g/m^3$	microgram per cubic meter

µm	micrometer
mg/cm^2	milligrams per square centimeter
mg/cm^3	milligrams per cubic centimeter
mg/h	milligrams per hour
mg/kg	milligrams per kilograms
mg/l	milligrams per liter
MWR	moral, welfare, and recreation
NCEL	Navy Civil Engineering Laboratory
NCI	National Cancer Institute
NIOSH	National Institute for Occupational Safety and Health
NSN	national stock number
OCONUS	outside continental United States
ODEP	Office of the Director of Environmental Programs
OHMIS	Occupational Health Management Information System
OSH	occupational safety and health
OSHA	Occupational Safety and Health Administration/Act
P2	pollution prevention
PCB	polychlorinated biphenyl
PCS	Permit Compliance System
PEL	permissible exposure limit
PERSCOM	U.S. Army Personnel Command
PL	Public Law
PPE	personal protective equipment
ppb	parts per billion
ppm	parts per million
RAC	Risk Assessment Code
RCRA	Resource, Conservation, and Recovery Act
R&D	research and development
RDT&E	research, development, test, and evaluation
SAIC	Science and Application International Corporation
SIC	Standard Industrial Code
SOP	standing operating procedure
TB MED	Technical Bulletin, Medical
TCLP	toxicity characteristic leaching procedure
TRADOC	U.S. Army Training and Doctrine Command

TSCA	Toxic Substances Control Act
USAEHA	U.S. Army Environmental Hygiene Agency
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USAARDEC	U.S. Army Armament Research, Development, and Engineering Center
USAR	U.S Army Reserve
USAREUR	U.S. Army, Europe
WESTCOM	U.S. Army Western Command

Section II
Terms

Current Department of Defense (DOD) and Army policy refers to lead-based paint (LBP) and LBP hazards. These two terms are defined in section 401, Title X of the Housing and Community Development Act of 1992, as follows:

LBP

Paint or other surface coatings with more than 1.0 milligrams per square centimeter (mg/cm^2) or 0.5 percent of lead by weight. The Housing and Urban Development (HUD) developed this definition for their own abatement purposes. It has no health basis but has been mistakenly treated and dealt with in policies and regulations as if it did.

LBP Hazards

Any condition causing exposure to lead that would result in adverse human health effects from lead in dust, soil, or paint. The lead does not have to come from LBP or, indeed, from paint at all. This 1992 definition reflects the growing understanding that paint with far less lead than would make it LBP can generate lead hazards; and lead in household dust may come from environmental, occupational, or hobby sources as well as deteriorating paint, while LBP in good condition and not child-accessible poses no hazard.

The next three terms are expected to appear in future Army policy. They are defined in draft Army policy as follows:

Lead-containing Paint

Lead-containing paint (in liquid form) is defined by the Consumer Products Safety Commission as any paint that contains more than six one-hundredths of one percent (0.06 percent) lead by weight (calculated as lead metal) in the total non-volatile content of the liquid paint. Lead-containing paint will not be used on any Army facility.

Leaded Paint

Leaded paint is defined by the Army as any paint (in dried film) which contains more than 0.06 percent lead by weight (600 parts per million).

Lead Hazards

Lead hazards are conditions that cause exposure to lead that would result in adverse human health effects as determined by the installation medical authority. Lead hazards include leaded paint that is deteriorated; levels of lead in soil and in dust on floors, window sills, and window troughs that exceed limits established by the U.S. Environmental Protection Agency (EPA); and leaded paint on friction or accessible surfaces.

Executive Summary

This guide provides information needed to comply with Federal, State, and local laws governing the use of lead and lead compounds on military installations. Federal regulation of lead is extensive and governs lead as a pollutant in air, water, soil, and during industrial use. Some states have issued their own regulations governing lead use. In a nutshell, the report can be summarized for the military commander in the familiar form of a five paragraph field order.

Situation: Lead is a highly toxic heavy metal with many applications on military installations, including: lead in paint, batteries, ammunition, solder, plumbing, tiles, and ceramics, and as a component of repair parts. Infants and children are especially vulnerable to lead poisoning. Adults may be adversely affected as well but at higher concentrations. Military and civilian personnel involved in a variety of activities may be exposed to unhealthy levels of lead. These activities include using indoor firing ranges, repairing lead-acid batteries, applying or removing leaded paints, or building demolition. Many other work scenarios at the installation expose workers to lead in presumably lower concentrations which may potentially result in adverse health affects.

Lead is regulated by a variety of Federal and State laws. These laws cover use, disposal, environmental cleanup, abatement in residential facilities, and occupational and workers' safety. Similarly, the Army has many programs for complying with these regulations including efforts to: reduce exposures of lead hazards from leaded paints in family housing; comply with Federal drinking water regulations; reduce use of lead-containing products; and establish safety, industrial hygiene, and medical programs to prevent/treat problems with lead. While regulations continue to grow, so does the Army program.

This guide focuses on issues of worker safety and health, specifically those military and civilian support personnel who may face a lead hazard during their day-to-day operations. It identifies potential mission-related hazards and suggests specific mechanisms to reduce risk (see the tables in Section 4). While the Army is focusing on initiatives to reduce the need for lead (e.g., as in ammunition and solder), much more needs to be done to ensure adequate protection of personnel. General and specific programmatic changes are discussed in detail in Section 5.

Mission: Ensure that lead is used properly and safely in support of the installation mission to protect the health and safety of the work force.

Execution: One way to accomplish the goal of a lead hazard-free installation is to form a lead hazard management team. Team members could include representatives from: facility management, logistic support, health and medical services, safety, environmental, legal, public affairs, and internal audit staff. A designated lead hazard coordinator should task the team to

employ a multidisciplinary, proactive approach to identify, monitor, manage, or eliminate lead hazards throughout the installation. Alternative approaches might include delegating this responsibility to the directors or commanders of each mission activity on your installation.

Support and Guidance: Support and guidance is essential to a successful program. This can be accomplished by:

- Implementing fully existing Army policies, programs, and procedures for lead-exposure reduction.
- Including lead as a priority pollutant in the installation pollution prevention program.
- Requesting adequate funding for and auditing of lead hazard reduction programs.
- Involving all assigned and tenant units and activities in the program.
- Reducing lead use or finding substitutes for lead.
- Educating installation staff, units, tenants, and residents about lead hazards and ways to reduce the hazards.
- Developing an inventory of all lead uses on the installation.
- Requesting major Army command (MACOM) support as necessary.

Additional support is available from other Army agencies, including: the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) [formerly, U.S. Army Environmental Hygiene Agency (USAEHA)], the United States Army Center for Public Works (USACPW), and the Army Environmental Center (AEC).

Command and Signal: A well organized installation team can implement an effective lead hazard reduction program, if it is a command priority. Ensure that a long-term management plan is put into place to identify, monitor, manage, and, if possible, eliminate lead hazards and monitor the status of the installation lead hazard reduction program as the Army implements new regulations on lead use. An effective program will avoid legal problems, protect human health and the environment, and help the installation execute its assigned missions.

1. Introduction

1.1 *What is the Problem with Lead?*

Lead presents a difficult problem for the Army: it is widespread, useful, and highly toxic. It is inexpensive to obtain, expensive to remediate, and may consume an increasing share of resources to protect human health and the environment. (See Appendix A for an explanation of the health effects of lead exposure.)

Annual lead consumption in the United States is 1.3 million tons. About 82 percent is used for lead-acid batteries, about 4 percent is used in ammunition, and the remainder is dispersed among all other uses of lead (Miller, 1994).

During the past 15 to 20 years, a phased reduction in leaded gasoline, the elimination of lead in house paint, the elimination of lead solder in cans for processed food, and a renewed public education effort have decreased dramatically the instances of lead poisoning in the general population. Yet, lead remains one of the most serious environmental and health problems facing the Army because of its wide use in Army mission activities. The use of lead is steadily increasing, and there is no economical substitute for its unique chemical properties and applications.

In November 1992, the Department of Defense (DOD) published a policy for lead-based paint (LBP) and LBP hazards in family housing and related structures (ROD 1992). That document is the first DOD policy statement on the problems of lead and is the start of a programmatic approach to eliminate the sources of childhood lead exposure on military installations. The policy focuses on the protection of children and fetuses because their rapidly developing nervous systems are especially vulnerable to lead poisoning.

However, lead poisoning also remains a serious threat to the Army's adult work farce (both soldiers and civilians) because of the lack of an Army-wide, standardized program to prevent or reduce exposure. Many miscellaneous but potentially severe lead-exposure sources associated with Army mission activities are difficult to control but require attention.

Lead is used in a variety of facility and military equipment applications, including lead batteries, ammunition, electronic circuitry, computers, radiation shielding, night-vision equipment, and ceramics in radars and sonars. Lead-contaminated soil, in both residential and training areas, is a problem with unknown consequences. Lead solder is still present in water supply lines and electronic equipment, and lead is in the paint on

some vehicles and weapons systems and in the paint in many facilities. These sources pose both a long- and short-term threat to the health of soldiers and civilian employees engaged in supporting Army operations and mission activities.

Army policies on lead-exposure reduction must address both acute (short-term), and chronic (long-term) exposure to lead and lead compounds. Programs are now in place to protect children under the age of six and expectant mothers. However, the Army needs to take a systematic, long-term approach to monitoring and protecting its total adult work force from lead exposure. Both continental United States (CONUS) and outside continental United States (OCONUS) policies and strategies should be developed to reduce or eliminate this potential health hazard.

1.2 *Purpose and Objectives of this Guide*

This guide will raise the awareness level of lead exposures from Army activities and will offer mission-area specific, lead-exposure control strategies which can be implemented by installations Army wide. The Army is participating in a cooperative effort between DOD and other Federal agencies to develop comprehensive policies and strategies for control and abatement of lead hazards in facilities regularly used by small children and pregnant women and lead in drinking water. Therefore, this guide will not address these issues but will focus instead on sources of lead exposure in other areas. Specifically, this guide will:

- Identify sources of lead exposure in Army mission activities which pose the most significant health risk;
- Review Federal laws and regulations intended to control lead hazards;
- Review current DOD and Army policies and programs for lead-exposure reduction;
- Examine Army health-monitoring data to identify those in the work force at risk from exposure to lead;
- Identify requirements to improve monitoring and management of lead-exposure data; and
- Recommend alternative strategies, materials, and management procedures to reduce or eliminate health risks to the Army work force.

This guide is about the health hazards from exposure to lead or lead compounds not the safety aspects of working with lead. Safety issues in the work place will be discussed only as they affect health. This guide outlines an installation level program to implement existing policy and to facilitate implementation of future policies.

1.3 *Benefits of a Lead Strategy*

Given the Army's fundamental policies of pollution prevention, materials substitution, and protection of human health, one might question why the Army should create a strategy specifically for lead. Existing policy, as well as ongoing research and development (R&D), seem to support a general program of lead reduction use or containment of lead hazards, as well as a program of legal compliance.

While general policy is in place, an implementing strategy seems to be needed, for the following reasons:

- A strategic lead plan in support of an overall Army pollution prevention program is essential for strictly military uses of lead in ammunition and in some military explosives.
- The Army's vehicle fleet is designed to use lead-acid batteries; any efforts to design a safer, maintenance free or more durable battery will have to be an Army level initiative.
- A generic lead strategy with recommendations for installations can save the Army considerable time, money, and financial resources.
- Major Army commands (MACOMs) and installation staffs could benefit from more detailed guidance for meeting reduction goals for specific substances.
- A lead strategy could serve as the linkage between centralized Army policy, procurement and research programs, and decentralized installation implementation of Army policies.
- The development of a lead strategy could reveal opportunities, economies, and efficiencies not foreseen by the initial policy development process.

2. Legislation, Policy and Regulatory Controls

Congressional concern about the lead content in drinking water supplies led to passage of the Safe Drinking Water Act. In response, Army policy has focused on lead hazards in drinking water and is now implementing comprehensive measures to test and correct elevated concentrations of lead in drinking water supplies.

The LBP Poisoning Prevention Act, enacted in 1971, initiated a national effort to control, reduce, or eliminate exposures to LBP. In 1992, Congress passed the Residential LBP Hazard Reduction Act (Title X of the Housing and Community Development Act of 1992). Title X mandates the preparation of guidance by U.S. Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA), and Housing and Urban Development (HUD) that is forthcoming. Training and certification of those performing LBP activities are required by Title IV amendments of the Toxic Substances Control Act (TSCA) of 1976, which are part of Title X; the implementing EPA regulations under part 745, title 40, Code of Federal Regulations (40 CFR 745) are pending.

Lead has come under extensive Federal regulation and this trend appears likely to continue. Federal statutes and Executive Orders (EOs) limit the release of lead or lead compounds into the work place and the environment. A listing of applicable Federal statutes and citations is contained at Appendix B, Annex 1.

2.1 *Department of Defense Policy for Lead*

2.1.1 Department of Defense Policy Documents

Policy on other sources of lead is provided in several documents which do not reference lead specifically but establish general health, safety, medical, and pollution prevention requirements for a variety of hazardous materials and wastes. For the most part, these policy documents are based on the Occupational Safety and Health Act (OSHA) of 1970 and implement both the regulations in 29 CFR 1910.134 and EO 12196, which directs that Occupational Safety and Health (OSH) Programs be established for all Federal employees. See Appendix B, Annex 2, for DOD policy documents.

2.1.2 Assessment of Department of Defense Policy

DOD policy establishes a comprehensive program for managing and reducing hazards to soldiers and civilian employees. These policies provide sufficient guidance to DOD components to establish programs capable of protecting the health of the work

force. DOD policy recognizes that protecting human health requires an interdisciplinary approach to meet compliance requirements.

DOD policy seems to implicitly recognize that control and containment strategies for hazardous materials and wastes will inevitably result in some exposure, and encourages the elimination or reduction in use of hazardous materials to protect human health and the environment. This emphasis on source reduction and elimination places existing policy in line with current and evolving policy on pollution prevention.

Various policy documents have been developed to include guidance on assessing health hazards unique to military training and operations which may not be covered by existing Federal regulations.

2.1.3 Emerging Department of Defense Policy

In April 1992, the Deputy Assistant Secretary of Defense (Health Budget Programs) directed the U.S. Army Engineering and Housing Support Center (EHSC) to establish a multi-agency task force to address LBP hazards in military family housing. This direction focused on producing safe, effective, and economical abatement and clean-up methods for LBP; the direction also focused on reducing exposure to lead in dust and soil. The EHSC assigned the responsibility for the Task Force to the Buildings and Structures Branch, Directorate of Public Works (DPW). The Task Force is examining a variety of health, management, environmental, and cost considerations associated with lead hazards.

With the Headquarters, Department of the Army (HQDA) reorganization in July 1993, oversight of the Task Force is now performed in the Buildings and Pavements Branch, Facilities Policy Division, Directorate of Facilities and Housing of the Office of Assistant Chief of Staff for Installation Management.

The Task Force, in creating policy, procedures, and programs for LBP in coordination with other Federal agencies, has produced several publications. The Task Force is currently investigating methods of testing for lead in paint, dust, and soil; lead-hazard reduction; and abatement. These efforts will result in a DOD policy memorandum and an implementing DOD Instruction.

Emerging DOD policy places emphasis on an interdisciplinary, installation team approach to reducing lead hazards, drawing upon the expertise of occupational health, industrial hygiene, environmental, safety, legal, and public affairs specialists at the installation. Final DOD policy for lead hazards will likely place an emphasis on reducing exposure to lead hazards rather than the complete removal of LBP.

2.2 *Department of the Army Policy for Lead*

2.2.1 Department of the Army Policy Documents

DOD policy for LBP hazards is contained in two documents, and is currently under revision. A description of several documents not typically considered to be policy documents has been included, since the procedures they prescribe are valuable inputs for policy development.

2.2.2 Assessment of Army Policy for Lead

Army policies for occupational health and safety, industrial hygiene, safety, environmental protection, and pollution prevention provide a broad foundation for an effective, compliance-based program to protect human health from lead hazards. Policy guidance has been translated into operational procedures for most uses of lead, including lead in ammunition used at indoor firing ranges and battery maintenance (both large sources of lead hazards).

Army policy for both lead hazards and lead in drinking water appears to be well developed; and the Army appears to be complying with established policies. Indoor range policies are in place and will be included in the revision of the Army regulation (AR) governing indoor firing ranges.

While Army policy supports reducing the use of hazardous materials as part of pollution prevention and waste minimization efforts, it does not appear that a program exists to specifically reduce or eliminate the use of lead, with the exception of lead-containing paint. Army policy seems to be primarily guided by legal compliance rather than systemic programs to reduce or eliminate lead use. No Army-wide program, with the exception of the LBP effort, exists to draw all Army policy into a single document with a single direction, nor does there appear to be a way to capture the full economic costs and benefits or health costs of lead use.

The Army's lead hazards program has been quite effective in protecting children from LBP exposure. Blood lead levels (BLLs) less than 10 micrograms per deciliter (µg/dl) were detected in 97.67 percent of children tested; this compares with the national average reported at 91.1 percent with BLLs less than 10 µg/dl (DOD, 1994; Alliance, 1994).

2.2.3 Draft Army Policy

Army policy for lead hazards is not static. Based on its extensive and successful experience with managing lead hazards and in response to new regulatory requirements, Army policy will be changed. The draft revisions to AR 200-1 establish, as Army policy, prohibition on acquiring and using lead-containing paint. Since the revised AR 200-1 will be a pure policy document, a companion document, Department of the Army Pamphlet (DA PAM) 200-1 will be published to provide more specific guidance. The DA PAM will contain guidance on lead hazards, establish a policy of managing leaded paint in place whenever possible, and recommend a multi disciplinary approach to lead hazard management.

AR 385-63, which governs training ranges, is currently under revision, and when published, will supersede HQDA Letter 385-93-2. The information contained in the HQDA letter will be incorporated into the revised AR.

U.S. Army Environmental Hygiene Agency (USAEHA) Technical Guide 198 provides the most current guidance for commanders to establish a Childhood Lead Poisoning Prevention Program/LBP-Management Program on their installations.

Army policy for other uses of lead appears to be an implicit policy of reduction in lead use in response to EO 12856. This EO requires a reduction in the release and off-site transfer of toxic materials, including lead. The U.S. Army Materiel Command (AMC) is currently reviewing all military specifications (MILSPEC) to identify all sources of lead, although the extent to which elimination of lead will occur is unclear.

Policy simply does not exist, or is not well understood, for the range of other activities which involve the use of lead. For some activities, such as soldering and welding, OSHA regulations constitute the de facto Army policy (Raeder, 1994). For other activities, such as weapons firing during live fire or maneuver exercises, there is no policy.

Army policy regarding lead in ammunition is still in a formative stage; no policy beyond an initial investigation of possible substitutes for lead appears to exist.

2.3 *Department of Defense and Department of the Army Initiatives to Reduce Lead Use*

Significant efforts to reduce lead use and exposure are ongoing in the Army and in the other Services. These efforts have the potential to substantially reduce or eliminate exposure to lead. These efforts include:

- ❖ The Army's research effort to eliminate lead from small arms ammunition (Vogelsang, 1994).
- ❖ The Army Training Support Center's (ATSC's) project to address problems with lead in ranges (Van Dervort, 1994).
- ❖ The Marine Corp's acquisition and installation of an innovative bullet containment system and Bureau of Mines lead remediation project at their facility in Quantico, Virginia (Fletcher, 1994; Rogers, 1994).
- ❖ The Army Research Laboratory's (ARL's) efforts to develop lead-free solders for use in electronic equipment (Am, 1994).
- ❖ The DA/DOD LBP Task Force's consistent progress in creating policies and integrating DOD efforts to reduce exposure to lead hazards.
- ❖ DOD initiatives to meet EO 12856 requirements, although not specifically directed at lead, will include plans and programs to reduce lead releases to the environment .

2.4 *Emerging Issues*

The prediction that restrictions on lead use will become more stringent was one shared by everyone interviewed for this guide. The Environmental Defense Fund (EDF), a private environmental advocacy group, is the group most involved in issues related to lead. EDF is supporting legislation which would help reduce the hazards posed by lead. The EDF representative responsible for their lead program predicts that new legislation and Federal regulation will impose additional restrictions on lead use (Florini, 1994).

Various substitutes for lead in ammunition are being developed by DOE and private industry (Harvey, 1994). The Olin Corporation, a major manufacturer of ammunition, has developed and is marketing a round of ammunition which has a lead-free primer and a fully jacketed lead bullet. This investment is indicative of the extent to

which the seriousness of the lead hazard, as well as the business potential of lead substitution, is taken (Frigiola, 1994).

The problems with lead in ammunition may require an examination of the larger issue of range operations and management. Emerging thought on range management may cause a redesign of military and civilian ranges to either prevent the break up of lead containing ammunition or to make the recovery and recycling of expended ammunition a part of the range design (Whiting, 1994).

While lead-containing paint (other than house paint) can still be used for certain exterior applications, draft Army environmental policy, existing Army engineering policy, and current Air Force policy prohibit its use. Paint industry representatives interviewed indicated that lead-free coatings perform as well as lead-containing paint(s) in exterior applications; some companies no longer manufacture lead-containing paint(s) (Martin, 1994; Dreibelbis, 1994).

Advocacy group and industry representatives agree that the most difficult item to find substitutes for will be lead batteries (Florini, 1994; Hunter, 1994).

State policy and regulation are a complex matter; however, it appears that the States are taking a regulatory interest in lead. For example, on August 31, 1994, the Pennsylvania Department of Environmental Resources issued a policy and procedure document to implement legislation governing lead-contaminated soil remediation actions. The policy establishes two standards for lead in soil: industrial use and non-industrial uses.

Lead, particularly LBP, is the subject of attention by small local advocacy groups, typically located in large urban centers. It is of particular concern to the environmental justice movement because of the prevalence of LBP in large cities with minority populations. Lead abatement has become a part of the environmental industry and is either a portion of environmental meetings and conferences or the subject of conferences devoted exclusively to lead. Some law firms specialize in cases of childhood lead poisoning (Bussert, 1994).

While it is difficult to extrapolate from trends in environmental issues to national legislation, it does appear that LBP is an issue of considerable concern which will not soon go away.

It appears that lead is becoming (or has already become) a substance analogous to asbestos, polychlorinated biphenyls (PCBs), and radon: an environmental “bad actor,” a health hazard, and a likely candidate for extensive: and continuous regulation. Lead is

regulated by Federal, State, and some local jurisdictions, and lead is one of the few toxics condemned for its particularly adverse effects on poor or minority populations.

3. Status of Army Monitoring and Testing Procedures

3.1 *Human Health Monitoring Data*

In response to a Congressional mandate in the Defense Appropriation Act of 1992, DOD initiated blood screening for all DOD dependent children under the age of six. Infants are tested between six months and one year of age, using a protocol established by the Centers for Disease Control (CDC) and management procedures established in the DOD policy memorandum on LBP (CDC, 1991; DOD, 1992). The blood samples for Army are tested at one of five Army medical facilities with certified laboratories. To date, less than 3 percent have been found to have elevated lead levels. If requested by a parent, or if medical personnel deem it appropriate, older children may be tested. Expectant mothers may be tested should medical personnel or the individual determine a need for testing. However, there is no program of universal screening for expectant mothers (DOD, 1994).

The Army's blood screening program for expectant mothers, infants, and children is driven by concerns about LBP and lead in drinking water. Army personnel and their dependents move frequently and reside in both military and civilian housing at home and abroad. As a result, drawing conclusions about exposure pathways or sources of lead is difficult (USAEHA Technical Guide No. 198). While each installation maintains information on the overall numbers of children tested, the Army lacks a central database to track exposure as children move from one installation to another. However, installation commanders have been aggressive in taking steps to reduce or control exposures to LBP in family housing and other buildings. These efforts have successfully protected children from lead paint hazards as evidenced by the results of screening for elevated BLLs in children.

No formal program of universal screening comparable to the child program exists for the DOD adult populations. Testing for lead is conducted when inspections or industrial hygiene surveys indicate that there is the possibility of occupational exposure, when BLL screening is required by OSHA regulations or at the request of the individual. However, widespread knowledge of the occupational exposure problem for those assigned duties at indoor firing ranges has caused indoor range staffs to be entered into medical surveillance programs.

No specific program exists for soldiers occupationally exposed to lead during weapons firing at outdoor firing ranges or during live-fire exercises. Data is lacking for the majority of the Army's civilian and military work force. Designing focused lead-exposure reduction programs will be made more difficult by this lack of information.

The CDC's National Institute for Occupational Safety and Health (NOSH) Adult Blood Lead Epidemiology and Surveillance Program (ABLES) monitors elevated BLLs among adults in the United States. Twenty-two states currently report surveillance results to ABLES. Their data suggests that work-related lead exposure is an ongoing occupational health problem in the United States (CDC, 1994).

3.2 *Occupational Health Monitoring Data*

AR 40-5 and Technical Bulletin, Medical (TB MED) 503 (to be superseded by DA PAM 40-503) establish a comprehensive program to implement OSHA programs on installations. The program is an integrated one, requiring the cooperation of the industrial hygiene, occupational health, and preventive medicine staff elements. The program includes recognition, monitoring, evaluation, data collection, staff assistance, and control to eliminate hazards.

The Occupational Health Management Information System (OHMIS) is the Department of the Army's (DA's) corporate standard for automated, occupational health management software. The Health Hazard Information Module (HHIM) is the industrial hygiene management tool within OHMIS. This database is the Army's central collection of information on occupational hazards, including lead exposures.

The HHIM, described in TB MED 503, is a computerized database, implemented at installation level, to collect and manage information on health hazards. The HHIM replaced the Local Occupational Health Hazards Inventory. The health hazard inventory is created by the installation industrial hygienist, and serves as a management tool for recording, tracking, reporting and eliminating health hazards on Army installations. Installations can obtain and use this information in planning a lead-exposure control program.

The HHIM contains valuable data pertaining to demographics, facilities, engineering controls, personal protective clothing and equipment, hazard inventories, priority action, exposure potential, personnel, risk assessment, air samples, bulk samples, noise samples, industrial hygiene instrumentation, and calibration. The user enters the coded survey data into the software via a keyboard, then subsequently has the ability to generate standard, detailed, or customized reports. Annually, the users download their personal computer data to diskettes, and the OHMIS programmers upload the

information to the OHMIS mainframe computer. The data are vital to industrial hygiene, occupational health, safety, and environmental programs Army wide. The HHIM provides information that enables the industrial hygiene program manager to develop a planned approach to implementing an effective industrial hygiene program. It identifies potentially exposed workers and their associated exposure levels. The software provides occupational health personnel with information that facilitates the assignment of appropriate, hazard-based medical surveillance. The HHIM allows for quick identification of uncontrolled workplace hazards, the delineation of required control measures, and the status of corrective hazard abatement actions. It can be used to determine health hazard education requirements and to defend and justify program resources.

One important piece of information recorded by the HHIM is the Health Hazard Risk Assessment Code (RAC). Assigned by the installation industrial hygienist, the RAC code prioritizes hazards. The Health Hazard RAC is a tool that DOD relies on to place some degree of standardization on the occupational exposure risks associated with widely varying operations. The RAC considers exposure level, exposure duration, and number of personnel potentially exposed to arrive at a single value (RAC 1-5). RACs are defined as: 1 = Critical, 2 = Serious, 3 = Moderate, 4 = Minor, and 5 = Negligible. Only RACs 1-3 were included in this guide, since RAC 4 and 5 exposures are of measurably less risk.

This was a deliberate decision meant to identify the most hazardous cases of lead exposure. Therefore, not every possible lead exposure was considered in this guide. Rather, only those exposures deemed to present a likely hazard to human health were considered. This decision ensured that any recommendations made targeted the most hazardous uses of lead. Existing industrial hygiene and safety practices have, in many cases, ensured that human health has been protected while lead has been used. This guide identifies situations where human health is more likely to be at risk, to guide action to protect human health where it is at risk, and to carefully target scarce resources.

An installation industrial hygiene program is an orderly progression from recognition of the hazard to evaluation of the risk to the work force to control or elimination of the health hazard in the workplace. The key factor in the overall program becomes the ability to identify or recognize potential health hazards. Installation level industrial hygienists bear the responsibility for identifying the sources of health hazards to the work force; their role and their ability are critical to the overall success of the program.

3.3 Deficiencies in the Current Army Approach Regarding Lead Pollution Abatement, Control, and Exposure Monitoring

Although the Army has an extensive and functioning approach to monitoring lead exposure and collecting data about lead exposure, three problems still exist within their system.

First, the HHIM tracks activities (such as welding, painting, and radiator repair) but not occupational codes. There is no inherent problem with tracking activities, such as brake relining, which are known to result in occupational exposure to lead. However, by not tracking by military occupational specialty (MOS) for soldiers and by civilian job code (CJC) for civilians, some high risk soldiers or civilian employees may be overlooked. For example, weapons repair is an activity which can expose soldiers or workers to lead. Only two installations in the HHIM database reported this activity; in fact, every installation and almost every military unit has someone designated as an armorer who repairs weapons. Typically, these soldiers are in the 76Y MOS. While the HHIM database does not include MOS or CJC, the corporate OHMIS mainframe data can be cross-referenced with the Defense Manpower Distribution Center personnel data (i.e., MOS and CJC) to generate that information.

Second, an information problem exists with contractor personnel working at government-owned, contractor-operated (GOCO) facilities. Typically, the contract with the government will require the contractor to comply with all applicable Federal laws regarding worker safety; this would include any legally required monitoring and medical surveillance. While this approach can be fully protective of human health, it does not include any requirement or method for industrial hygiene data to be entered into the HHIM database. This means that information of potential value for Army efforts to reduce lead exposure is not being entered into Army information management systems.

Finally, existing data collection efforts are not well integrated into other Army management systems. For example, the HHIM is not presently integrated into installation or Army level safety programs, and there appears to be little integrating information between occupational health and safety programs at any level. The OHMIS does not appear to be well integrated into the Army's Environmental Compliance Assessment System (ECAS), primarily because there has been no perceived need by the Army environmental program managers for this integration. There has been some integration with Army-conducted pollution-prevention opportunity assessments (Morgan, 1995). However, work is ongoing to interface OHMIS with Safety's Installation Support Module (ISM), DOD Corporate Information Management (CIM) Hazardous Material Management System, and the Defense Environmental Security CIM effort. Programs are in place to monitor and correct elevated lead levels in drinking water;

however, there are no data available to determine the exposure level to soldiers and civilians from this source.

The low level of integration results in a reduction of data reporting to the HIM making evaluation of Army-wide lead exposures difficult. Because industrial hygiene evaluation results often remain at the installation, the HHIM data represent only a subset of the Army's exposure information. Exact numerical conclusions cannot be drawn from the HHJM data regarding the number of facilities performing a specific operation, the frequency with which that operation occurs, or the number of potentially exposed personnel. While a quantifiable risk assessment is not possible with the available data, the risk evaluations identify areas of greater risk of exposure.

Future data collection efforts will be hampered by the lack of a complete inventory of lead sources on Army facilities including leaded paint, lead in drinking water, or lead from other sources. Integration of this data, with occupational exposure survey data from U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) [formerly U.S. Army for Environmental Hygiene Agency (USAEHA)] and blood monitoring data at installation level would provide an appropriate database from which to monitor and manage lead abatement and control programs. Since there is no consistent methodology for reporting lead monitoring data on Army installations, establishing a benchmark level of lead at installations will prove difficult or impossible. Specific recommendations to address these deficiencies are presented in Section 5 of this guide.

4. Army Mission-Area Strategies for Lead Hazard Control

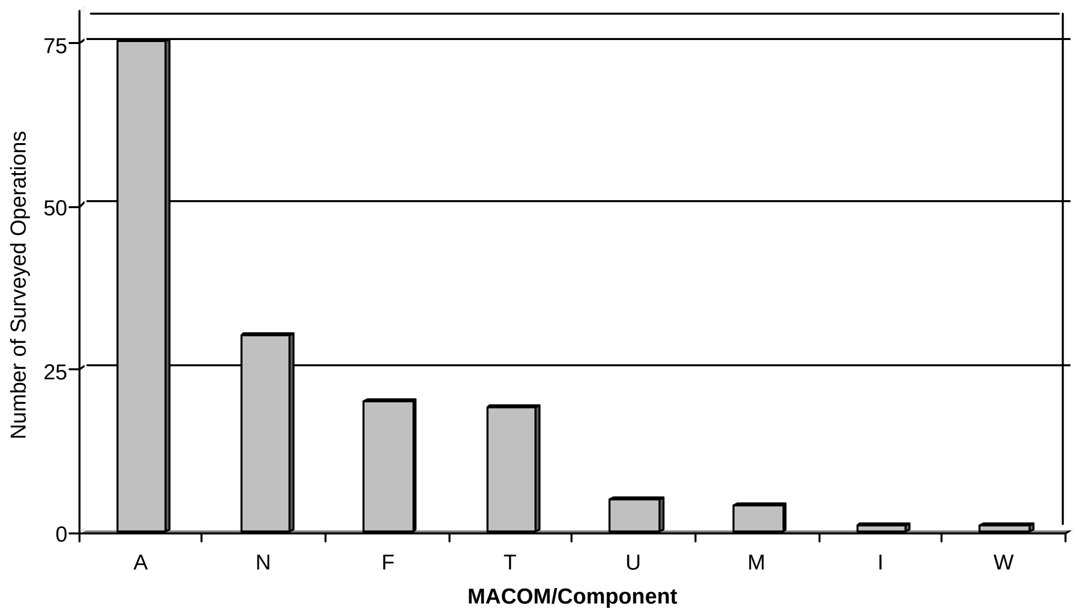
The five Army mission areas described in this section include tasks that have shown a significant potential for worker exposure to lead in excess of the maximum limits established by OSHA. These mission areas are: Training and Readiness, Logistical Operations, Industrial Operations, Base Operations, and Health and Medical Operations (Appendices B through G). Occupational health survey data are used to identify those activities posing the highest potential risk of lead exposure in each mission area. Appendix L provides a complete listing by mission area of the mission-area activities and relative risk categories from the HHIM database. Within each mission area, alternative approaches and strategies are offered for reducing exposure levels.

The data used to compile the frequency graph are derived from the HHIM. The sampling pattern indicates that, while AMC has received a high level of surveys, sampling is not as extensive in the MACOMs which conduct extensive training activities. The survey data suggest that some mission areas may not be receiving all the attention they require. Given the large amount of equipment maintenance and training which

occurs in USAREUR, the lack of information on USAREUR may be especially problematic.

The graph shown in Figure 4-1 indicates the distribution of sampling surveys among MACOMs:

Figure 4-1. Number of Industrial Hygiene Sampling Surveys of Lead-Associated Operations Included in HHIM from 1987-1994, by Major Command/Component



A = U.S. Army Materiel Command (AMC)
N = Army National Guard (ARNG) or U.S. Army Reserve (USAR)
F = U.S. Army Forces Command (FORSCOM)
T = U.S. Army Training and Doctrine Command (TRADOC)
U = U.S. Army, Europe (USAREUR)
M = U.S. Army Medical Command (MEDCOM)
I = U.S. Army Intelligence and Security Command (INSCOM)
W = U.S. Army Western Command (WESTCOM)

4.1 *Training and Readiness*

4.1.1 Description of Mission Area

Commanders must be allowed maximum discretion in preparing their units to execute Army missions in support of the national military strategy. All other mission areas and all staffs and support systems must plan their activities to provide commanders that freedom of action in training and readiness.

Training and readiness is the most critical mission area for Army commanders, and all installations and Army commanders have some responsibility for training and readiness. Generally, Army training is conducted as individual training, unit/collective training, or as combined arms training, which can take a wide variety of forms.

Individual training activities include basic training, which almost all soldiers will engage in, ranging from individual weapons' training to highly specialized training in a very wide range of MOS for various groups. Some training is similar to classroom training conducted in high schools or colleges. Some training involves using practical exercises that expose soldiers to elemental lead or lead compounds.

Collective training, as the title implies, consists of training groups to perform unit or organizational tasks. This training is performed in the field or in installation training areas; this training ranges from small unit exercises to very large combined arms exercises involving large concentrations of personnel and equipment.

Other mission areas, including logistical, maintenance, transportation, medical support, and base operations, are required to support training and readiness.

Army training facilities and lands are coming under increasing regulatory pressure from a variety of sources; most stem from encroachment of urban areas and Federal legislation, such as the Endangered Species Act. Although precise needs are difficult to predict, new weapons systems may present requirements not only to maintain existing areas but also to acquire new areas. Emerging problems for Army trainers are lead contamination of soil and potentially adverse health effects of lead contaminated soil on troops using the training area.

Lead is a constituent of ammunition and vehicle batteries; both commodities are essential to maintaining readiness. The ballistic properties of lead, and its value as a component of primers, make it valuable for high quality military ammunition. Lead performs well as a storage battery in vehicles and is used in large quantities, particularly in larger military vehicles.

Other, less common uses of lead in support of training and readiness include leaded paint on military equipment, lead solder used in facility and equipment repair activities, and lead as a component of metal alloys. These are support activities, primarily matters of supply and maintenance, and are common to other Army mission areas.

4.1.2 Training and Readiness - Risk-Reduction Strategy

Risk-reduction strategies for this mission area will require a combination of expanded implementation of existing Army programs for lead-exposure reduction, research to determine if other exposure pathways (such as outdoor weapons firing) present an exposure pathway, and DA level activities to remove lead from ammunition and batteries.

DA programs to control lead exposure at indoor firing ranges and Army research initiatives to reduce or eliminate lead from small arms ammunition have the potential to greatly reduce lead exposure. The Army's industrial hygiene, occupational health, and pollution prevention programs represent assets with the ability to control lead exposure and to ultimately eliminate sources of lead exposure.

4.1.3 Lead Sources and Control Strategies

Table 4-1 depicts training and readiness activities which can result in lead exposure and recommends control strategies.

Table 4-1. Lead Sources and Control Strategies - Training and Readiness

Activities with Lead Exposure Potential	Example Tasks	Control Measures	Comments
Indoor Firing Ranges	Firing, cleaning, managing	PPE*, Engineering Controls, Training	Problems and control measures are well documented.
Outdoor Weapons Firing	Firing, collection of expended brass, grounds maintenance	Training	More research is required to determine extent of exposure.
Weapons Maintenance	Cleaning, repairing	Train ing	Weapons contaminated with lead from bullets and primers may present a source of exposure.
Vehicle Operations	Driving, maintenance	Training	Lead in dust generated by vehicles may be an exposure source.
Field Maintenance Operations	Welding, soldering grinding, painting, batter maintenance	PPE, Engineering Controls, Training	Similar to maintenance performed in the logistical and industrial mission areas.
Field Fortifications	Blasting, digging, grading	Training, Testing	Lead in soil may be an exposure source.
Live Fire and Maneuver Exercises	Weapons firing, vehicle operation	Training	Lead exposure may come from lead in soil and ammunition primers.
Field Water Supplies	Water production and consumption	Testing, Training	Supplies are normally tested; lead in soil can be a potential contaminant.
Ammunition Maintenance	Paint and corrosion removal, painting	Training, Testing	Lead in paint and in some primers present a hazard.
Ammunition Residue	Collection, consolidation and storage of expended brass	PPE, Training	Possibility of hand to mouth transfer of lead for those handling brass.
MOS* Training	Training plumbers to work with lead	PPE, Engineering Controls Training	May involve all MOSS requiring work with lead containing materials.
Illegal Activities	Theft of lead waste melting to make bullets or scuba diving weights	Inventory Control, Training	Extent of problem unknown.

*PPE = Personal Protective Equipment; MOS = Military Occupational Specialty

4.1.4 Exposure Control Methods

Table 4-2 suggests control measures which may be appropriate to reduce or prevent lead exposure during the activities conducted in the training and readiness mission area. Both a qualified industrial hygiene specialist and the supervisor of the activity should jointly decide what is appropriate in each specific setting. In some cases, environmental and safety specialists may be able to contribute to exposure reduction.

The suggestions in Table 4-2 were drawn from OHMIS industrial hygiene information and accepted industrial hygiene practices.

Table 4-2. Exposure Control Methods - Training and Readiness

Training and Readiness Activities	**Testing ****	**Appropriate Exposure Control Methods**					
		GMV***	**LEV*****	**Ventilated Booths**	**Hygiene/ Housekeeping**	**PPE*****	**Awarenes s**
Indoor Firing Ranges		?		?	?	?	?
Outdoor Weapons Firing					?		?
Weapons Maintenance*					?	?	?
Vehicle Operations					?		?
Field Maintenance Operations	?		?		?	?	?
Field Fortifications	?				?		?
Live Fire and Maneuver Exercises					?		
Field Water Supplies	?						?
Ammunition Maintenance	?				?		?
Ammunition Residue					?	?	?
MOS*** Training	?	?	?	?	?	?	?
Illegal Activities							?

*Various control measures may be appropriate depending upon the level of maintenance.
**Analyzing materials for lead content (paints, metals, soils, etc.) can facilitate proper selection of control methods.
***GMV = General Mechanical Ventilation; LEV = Local Exhaust Ventilation; PPE = Personal Protective Equipment; MOS = Military Occupational Specialty

4.2 *Logistical Operations*

4.2.1 Description of Mission Area

Logistical operations typically include supply, maintenance, transportation, facilities, and services staffed by both soldiers and civilian employees. Logistical operations take place at all organizational levels in the Army and have as their primary

objective the support of combat forces. Almost all military units have some type of organic logistical capability. The Army force structure contains purely logistical support units as well: ammunition supply companies, transportation units, repair parts companies, and maintenance units. Many of these units are in the reserve components and are activated only for training or national emergencies.

Installations are organized, staffed, and equipped to provide logistical support to assigned and tenant units or activities. While military logistical units are mobile, most installation logistical operations are conducted from fixed facilities. Typically, installation logistical operations provide direct or general support beyond the capability of assigned and tenant units or activities.

AMC provides depot level support, primarily in the areas of supply and maintenance, not only to the Army but to the other Services. AMC operates a variety of logistical depots which provide supplies and perform sophisticated maintenance and manufacturing activities. AMC is responsible for the manufacturing, storage, and maintenance of ammunition, and supervises the operation of the Army's ammunition plants. Other AMC activities influence Army logistical operations, which will be discussed in Section 4.3.

The Army's Military Traffic Management Command (MTMC), part of the Transportation Command, handles surface (land and sea) transportation for all the Services.

The USAR operates Consolidated Regional Maintenance Centers which support Army Reserve units across the United States. These centers provide direct and general support maintenance to Army Reserve units not provided by active Army installations.

Logistical operations tend to vary in organization and function, depending on the units or activities being supported. Army logistical operations overseas are often performed by host nation employees. During mobilization and deployment, logistical operations can expand dramatically to include very large, integrated, task-organized units with responsibilities extending over thousands of miles.

Logistical operations can span the full range of support activities ranging from a small military unit armorer's responsibilities for the repair of small arms to a Theater Army Area Command's responsibility for transporting and distributing millions of gallons of fuel and thousands of tons of ammunition daily. However, this section focuses on the logistical operations more commonly performed by unit and installation logistical personnel.

4.2.2 Logistical Operations - Risk-Reduction Strategy

Risk-reduction strategies for this mission area will require a combination of expanded implementation of existing Army programs for lead-exposure reduction, research to determine if other exposure pathways (such as manual cleaning of lead-acid battery posts) present an exposure pathway, and DA-level activities to eliminate lead from paint used on military equipment.

DA programs eliminating the use of lead-containing paint on all facilities and the Army's occupational health, safety, and industrial hygiene programs form a foundation upon which enhanced levels of protection can be achieved. Additional research on exposure pathways resulting from field maintenance operations is required. Designing lead-acid batteries requiring less maintenance by vehicle operators would help eliminate a potential exposure pathway. The ARL's initiative to develop a lead-free solder for electronic equipment represents a long-term project which can help to reduce or eliminate a source of lead exposure.

4.2.3 Lead Sources and Control Strategies

Table 4-3 depicts logistical activities which can result in lead exposure and recommends control strategies.

4.2.4 Exposure Control Methods

Table 4-4 suggests control measures which may be appropriate to reduce or prevent lead exposure during the activities conducted in the logistical mission area. Both a qualified industrial hygiene specialist and the supervisor of the activity should jointly decide what is appropriate in each specific setting. In some cases, environmental and safety specialists may be able to contribute to exposure reduction. The suggestions in Table 4-4 were drawn from OHMIS industrial hygiene information and accepted industrial hygiene practices.

Table 4-3. Lead Sources and Control Strategies - Logistics

Activities with Lead Exposure Potential	Example Tasks	Control Measures	Comments
Material Handling	Packaging, issuing, shipping, storing, and disposing of lead containing materials	PPE', Training	Potential exposures are variable and commodity specific.
Maintenance Activities	Soldering, welding, paint removal and application, metal working	PPE, Engineering Controls, Training	Lead in paint, wheel weight solder, and batteries are the source of most exposures.
Vehicle MHE* operation	Clearing and servicing lead acid batteries, operation changing wheel weights.	PPE, Training	Primarily operator maintenance activities.
Operating Logistical Facilities	Using and maintaining facilities containing leaded paint	Implement Army LBP' Procedures	Leaded paint is more likely to be in logistical than in residential structures.
Operating Salvage Yards	Equipment disassembly, metal cutting, salvage	PPE, Training	Potential exposure from leaded paint on equipment and from lead in batteries and radiators.
Purchasing and Contracting	Writing and reviewing specifications	Implement Pollution Prevention Hierarchy.	Education may be needed for the procurement community.

*PPE – Personal Protective Equipment; MHE = Material Handling Equipment; LBP – Lead-based Paint

Table 4-4. Exposure Control Methods - Logistics

Logistical Operations	Testing *	Appropriate Exposure Control Methods					
		GMV**	LEV**	Ventilated Booths	Hygiene/ Housekeeping	PPE**	Awareness
Materials Handling					?	?	?
Maintenance Activities	?	?	?	?	?	?	?
Vehicle and MHE** Operation					?	?	?
Operating Logistical Facilities	?				?		?
Operating Salvage Yards	?				?	?	?
Purchasing and Contracting							?

*Analyzing materials for lead content (paints, metals, soils, etc.) can facilitate proper selection of control methods.
**GMV = General Mechanical Ventilation; LEV = Local Exhaust Ventilation; PPE = Personal Protective Equipment; MHE = Material Handling Equipment

4.3 *Industrial Operations*

4.3.1 Description of Mission Area

Army industrial operations include a wide range of activities in support of not only the Army but the other Services as well. These include manufacturing of propellants, explosives, and pyrotechnics; maintenance, repair, rebuild, and modification of supplies and equipment; production, storage, maintenance, testing, modification, and disposal of ammunition; and research, development, test, and evaluation (RDT&E) activities.

Most Army industrial operations are carried out by the AMC. However, the USAR and ARNG maintain facilities which perform maintenance activities on regional support basis, and the USAREUR maintains extensive equipment and supply storage sites which perform some industrial operations.

For this guide, industrial operation will be defined as general support maintenance, depot and manufacturing plant operations, theater-level supply and storage operations, and activities undertaken by the Defense Reutilization and Marketing Office (DRMO).

By contrast, logistical operations (as discussed in Section 4.2) will be defined as direct support and lower-level maintenance operations, nonindustrial installation-level activities, and military-unit logistical activities.

This distinction is not a fine one. Industrial operations at an Army depot involved in equipment modification may be indistinguishable at times from equipment maintenance activities conducted by an installation Director of Logistics. However, the volume of activity, and the organizational setting of the activity, create enough differences so that industrial operations may be separated from logistical operations.

The vast majority of Army industrial operations are carried out by Army civilian employees or by government contractors working for the Army. In other countries, the Army employs citizens of the host nation or of other nations.

Typically, lead hazards in Army industrial operations are controlled or regulated in the same way they are regulated in comparable civilian industries because many of these operations are conducted at GOCO facilities.

Army industrial operations also function in support of deployed Army forces. During mobilization and deployment, materials requirements may demand very sudden, rapid increases in production. These production surges have the potential to create hazardous working conditions unless adequate planning has taken place.

Industrial operations are particularly significant for a lead-exposure reduction strategy; the choices of materials by the manufacturing facilities will determine how much lead exposure will occur during installation and military unit logistical operations.

4.3.2 Industrial Operations - Risk-Reduction Strategy

Risk-reduction strategies for this mission area will require a combination of expanded implementation of existing Army programs for lead-exposure reduction and the elimination, to the greatest extent possible, of lead in commodities such as ammunition, paint, solders, and alloys.

DA safety, industrial hygiene, and occupational health programs can make substantial contributions to reducing the possibility of lead exposure during industrial operations. The Army's pollution prevention program can be an asset which could be used to help identify ways of reducing or eliminating lead used in Army industrial operations; existing Army initiatives to eliminate lead from paint and solder could greatly reduce the possibility of lead exposures.

4.3.3 Lead Sources and Control Strategies

Table 4-5 depicts industrial operations which can result in lead exposure and recommends control strategies.

4.3.4 Exposure Control Methods

Table 4-6 suggests control measures which may be appropriate to reduce or prevent lead exposure during the activities conducted in the Industrial mission area. Both a qualified industrial hygiene specialist and the supervisor of the activity should jointly decide what is appropriate in each specific setting. In some cases, environmental and safety specialists may be able to contribute to exposure reduction. The suggestions in Table 4-6 were drawn from OHMIS industrial hygiene information and accepted industrial hygiene practices.

Table 4-5. Lead Sources and Control Strategies - Industrial Operations

Activities with Lead Exposure Potential	Example Tasks	Control Measures	Comments
Manufacturing	Soldering, welding, painting	Engineering Controls, PPE*, Training	Commodity and process specific exposures.
Modification and Maintenance	Paint removal, painting, soldering,. Cutting, welding	Engineering Controls, PPE, Training	Testing of paint on older equipment is recommended.
Ammunition Manufacturing	Forming and shaping of bullets, productions of primers	Engineering Controls, PPE, Training	Includes ammunition demilitarization.
COSIS*	Cleaning, servicing, testing, replacing lead-containing components	PPE, Training	Identification of pathways may be difficult.
RDT&E* Activities	Various, includes weapons and materials testing	Engineering Controls, PPE, Training	P2* effort can eliminate lead during material development.
Facility Operations	Repairing water lines	Training	Include industrial facilities in lead hazard management program.

*PPE = Personal Protective Equipment; COSlS = Care of Supplies in Storage; RDT&E = Research, Development, Test, and Evaluation; P2 = Pollution Prevention

Table 4-6. Exposure Control Methods - Industrial Operations

Logistical Operations	Testing *	Appropriate Exposure Control Methods					
		GMV**	LEV**	Ventilated Booths	Hygiene/ Housekeeping	PPE**	Awareness
Manufacturing	?	?	?	?	?	?	?
Modification and Maintenance	?	?	?	?	?	?	?
Ammunition Manufacturing			?		?	?	?
COSIS**			?		?	?	?
RDT&E**	?	?	?	?	?	?	?
Facility Operations	?				?		?

*Analyzing materials for lead content (paints, metals. soils, etc.) can facilitate proper selection of control methods.
**GMV = General Mechanical Ventilation, LEV = Local Exhaust Ventilation, PPE = Personal Protective Equipment, COSlS = Care of Supplies in Storage; RDT&E = Research, Development, Test, and Evaluation

4.4 *Base Operations*

4.4.1 Description of Mission Area

Base operations consist of the facility support activities required to accomplish the missions and functions of assigned and tenant units at installations. Base operations include: utilities support; security operations; facilities operations and maintenance; health and medical; transportation systems; master planning; military construction; information management; communications; personnel management; family housing operations; waste management; logistical support; and morale, welfare, and recreation (MWR) activities. These activities are typically managed by the garrison commander through the various directorates and the installation staff. Health and medical activities and logistical operations are covered as separate mission areas in this guide.

Base operations are roughly analogous to civic management and community development; at installations, these activities are both vital and variable. Specific activities will not be identical from installation to installation, although programs tend to be fairly consistent across installations. Many base operations activities are carried out by contractors. OCONUS installations typically employ local national contractors.

Base operations are complex, complicated activities which affect everyone on the installation. These operations are not merely ancillary to the military mission. Rather, effective and efficient base operations contribute directly to accomplishing the installation's wartime and peacetime missions by providing the physical means to sustain daily life and military activities on installations. The efficiency and effectiveness of an installation's base operations program will help determine the quality of life and state of morale at an installation; these have a direct bearing on the installation's ability to conduct activities supporting mobilization and deployment.

4.4.2 Base Operations - Risk-Reduction Strategy

Risk-reduction strategies for this mission area will require multiple actions by numerous elements on Army installations. Base operations is an inherent installation level function; reducing the risk of lead exposure at installations requires a coordinated, integrated team effort at installation level. The existing DA program for LBP hazards, combined with installation level occupational health, industrial hygiene, and pollution prevention programs, can make significant progress in eliminating lead hazards during base operations.

Education and awareness can contribute significantly to the reducing or eliminating lead hazards during base operations. Eliminating lead from basic commodities helps to ensure that future problems will be eliminated.

4.4.3 Lead Sources and Control Strategies

Table 4-7 depicts base operations which can result in lead exposure and recommends control strategies.

4.4.4 Exposure Control Methods

Table 4-8 suggests control measures which may be appropriate to reduce or prevent lead exposure during the activities conducted in the base operations mission area. Both a qualified industrial hygiene specialist and the supervisor of the activity should jointly decide what is appropriate in each specific setting. In some cases, environmental and safety specialists may be able to contribute to exposure reduction. The suggestions in Table 4-8 were drawn from OHMIS industrial hygiene information and accepted industrial hygiene practices.

Table 4-7. Lead Sources and Control Strategies - Base Operations

Activities with Lead Exposure Potential	Example Tasks	Control Measures	Comments
Facility Operations	Plumbing, painting, cleaning street sweeping	Engineering Controls, PPE* Training	Exposure to lead from environmental sources, paint, plumbing
Infrastructure Construction and Revitalization	Removal of paint from steel structures, using leaded paint for traffic markings	Engineering Controls, PPE, Training	Exterior leaded paint is the largest source of lead.
Family Housing	Painting, paint removal, repairs	PPE, Training	Implement Army lead hazard program.
MWR* Activities	Ceramics, pottery stained glass window making, printing, sewing	Engineering Controls, PPE, Training	Lead releases are extensively regulated.
Utilities	Solid waste management and incineration	PPE, Training	Lead releases are extensively regulated.
Family Demolition	Heavy equipment operation, burning, Landfilling	PPE, Training	DOD and DA have published policies.
Soil Removal	Remediation, land management	PPE, Training	Sources of lead in soil include lead from gasoline; lead-containing paint removal; salvage and burning.

*PPE = Personal Protective Equipment; MWR = Morale, Welfare, and Recreation

Table 4-8. Exposure Control Methods – Base Operations

Logistical Operations	Testing *	Appropriate Exposure Control Methods					
		GMV**	LEV**	Ventilated Booths	Hygiene/ Housekeeping	PPE**	Awareness
Facility Operations	?		?	?	?	?	?
Infrastructure Construction and Revitalization	?		?		?	?	?
Family Housing	?				?	?	?
MWR** Activities	?		?	?	?	?	?
Utilities	?				?	?	?
Facility Demolition	?				?	?	?
Soil Removal	?				?	?	?

*Analyzing materials for lead content (paints, metals, soils, etc.) can facilitate proper selection of control methods.
**GMV = General Mechanical Ventilation; LEV = Local Exhaust Ventilation; PPE = Personal Protective Equipment; MWR = Morale, Welfare, and Recreation

4.5 *Health and Medical Services*

4.5.1 Description of Mission Area

Army health and medical. facilities include Medical Centers (MEDCEN), U.S. Army Community Hospitals, Medical Clinics, Dental and Veterinary Clinics, Medical Treatment Facilities (nonfixed), and various types of laboratories. Most of these facilities are tenant units located on almost every Army installation. The size of these facilities varies and USACHPPM has general estimates of waste stream volumes. The MEDCOM reports that there are approximately 55 hospitals operating on Army installations worldwide. Each hospital is usually accompanied by a dental and veterinary clinic. These hospitals contain over 6,000 beds with an average occupancy rate of 78 percent. They report the Army has approximately 20 operating incinerators at Army facilities where medical and other waste are burned.

Health and medical services include activities undertaken by Army personnel in the following facilities: hospitals, clinics, dental offices, medical and dental laboratories, and nursing, personal, and veterinary-care facilities. Hospitals use the most chemical substances and generate the largest percentage of waste. It has been reported to Congress

that 93 percent of all medical wastes are generated from hospitals alone (EPA Report to Congress, 1990). Army health and medical facilities are similar to civilian medical facilities. They perform the same procedures and tests and provide similar patient care. Therefore, it is possible to generalize from data on civilian healthcare facilities and apply it to Army facilities.

Lead exposure to Army personnel can occur in various operations at Army health and medical facilities. Occupational exposure to lead can occur in such processes as radiation therapy, dental procedures, or cleanout of incinerators. The operations discussed in this section have less potential for significant exposures to lead than those operations detailed in previous sections. This is due to the lower number of personnel performing the work and the higher levels of hygiene associated with health and medical services. Ten Army industrial hygienists were interviewed to compile the tasks described here. Airborne sampling data does not exist in the HHIM database because some of the lead sources listed here were not known. Therefore, no attempt to prioritize risks among these tasks is made in this section.

4.5.2 Health and Medical Activities - Risk-Reduction Strategy

Risk-reduction strategies for this mission area will depend, for the most part, upon initiatives within medical facilities. Most sources of lead exposure can be eliminated by substitution, inexpensive containments methods, and awareness. Testing or manufacturer information should be used to confirm lead content of materials employed.

The problem of lead exposure resulting from incinerator ash will most likely require a combination of individual medical facility actions to eliminate lead containing material from the waste stream, along with DA action to develop alternative waste disposal methods. Education and awareness of lead hazards in medical facilities can be facilitated by centralized DA guidance.

Health and medical services activities expose soldiers and civilian employees to lead in a variety of ways. The potential lead exposures discussed below will not be present at every facility, given the varying services provided at different size facilities. Some of these activities are well understood; others have not been extensively researched. While the great majority of personnel will never come in contact with lead, a few may perform tasks that present a low but regular exposure potential.

4.5.3 Lead Sources and Control Strategies

Table 4-9 depicts health and medical activities which can result in lead exposure and recommends control strategies.

4.5.4 Exposure Control Methods

Table 4-10 suggests control measures which may be appropriate to reduce or prevent lead exposure during the activities conducted in the health and medical mission area. Both a qualified industrial hygiene specialist and the supervisor of the activity should jointly decide what is appropriate in each specific setting. In some cases, environmental and safety specialists may be able to contribute to exposure reduction. The suggestions in Table 4-1 0 were drawn from OHMJS industrial hygiene information and accepted industrial hygiene practices.

Table 4-9. Lead Sources and Control Strategies - Health and Medical Activities

Activities with Lead Exposure Potential	Example Tasks	Control Measures	Comments
Dental Procedures	Changing old fillings, grinding dental plates	Enclosure for Grinding, PPE*	Old dental work and that of foreign countries contain lead.
Dental Impression Chemicals	Handling lead silicate while preparing impression	PPE, Training	Training in hygienic practices
Forming Metal Prosthetic Braces	Pouring and casting metal, clean out of metal furnace	LEV*, PPE, Training	Metal fumes from pouring lead-containing metal
Radiation Therapy Procedures	Crafting lead bricks by pouring, drilling or grinding, handling lead bricks during therapy	LEV, PPE, Training	Hand-to mouth transfer of lead for those without PPE.
Autoclave Procedures	Handling white to black autoclave tape	PPE, Training	Lead in tape creates hand-to mouth transfer hazard
Medical Maintenance	Painting, plumbing soldering	Engineering Controls, PPE, Training	Similar to facility maintenance.
Occupational Ceramics	Use of lead-containing glaze, kiln clean-out	Substitution, PPE, Training	Occupational therapists or custodians may be the only personnel with potential exposure.
Medical Waste	Clean-out and disposal of incinerator ash	PPE, Training	Ash may contain lead from burning plastics, metal, inks, etc.
Laboratory and Veterinary Facilities	Activities similar to many of those above	See above	Laboratory and veterinary facilities may perform tasks similar to those above.

*PPE = Personal Protective Equipment; LEV = Local Exhaust Ventilation

Table 4-10. Exposure Control Methods - Health and Medical Activities

Health and Medical Activities	Testing *	Appropriate Exposure Control Methods					
		GMV**	LEV**	Ventilated Booths	Hygiene/ Housekeeping	PPE**	Awareness
Dental Procedures				?	?	?	?
Dental Impression Chemicals						?	?
Forming Metal Prosthetic Braces	?		?		?	?	?
Radiation Therapy Procedures			?		?		?
Autoclave Procedures	?					?	?
Medical Maintenance		?	?		?		?
Occupational Ceramics						?	?
Medical Waste Incineration	?				?	?	?
Laboratory and Veterinary Facilities		?	?	?	?	?	?

*Analyzing materials for lead content (paints, metals, soils, etc.) can facilitate proper selection of control methods.
**GMV = General Mechanical Ventilation; LEV = Local Exhaust Ventilation; PPE = Personal Protective Equipment

5. Conclusions and Recommendations

5.1 *General Recommendations*

The Army could achieve additional savings and efficiency by developing an installation focused strategy for lead. Policy initiative programs under way at the DOD, DA, and MACOM level should be coordinated into a single approach to the resolution of lead-exposure problems at installation level. When creating an Army installation strategy for lead, consider these trends:

- ❖ Lead is regulated and monitored at the international level.
- ❖ External regulation of lead at the Federal, State, and local level is likely to become more, rather than less, stringent.

- Various EOs, EPA programs, and DOD pollution-prevention initiatives will require closer identification and tracking of lead use, and will encourage reduction in lead use.

- The technical ability to detect lead contamination on body surfaces, clothing, and other materials, using relatively simple tests, is increasing.

- Both private industry and Army R&D organizations are investigating reduced lead or lead-free ammunition, solder, and paints.

- The Army has a "backlog" of lead in much of its equipment and in many of its training ranges, infrastructure, and facilities.

- Developing Army policy on lead hazards is moving towards the concept of ensuring hazard free, not lead-free, environments; Army policy now prohibits the acquisition and use of lead-containing paint on facilities Army wide.

- Managing lead on installations now includes safety, occupational health, industrial hygiene, medical, and environmental management programs necessary to protect human health. The cost of lead use by the Army includes the cost of these programs.

- Public awareness of the potential problems resulting from lead exposure is increasing.

- Various Army pollution prevention initiatives have either reduced the use of lead or will begin to consider initiatives to reduce the use of lead.

- Certain uses of lead present little or no hazard to human health and represent an inexpensive way of meeting mission requirements.

- Simple personal hygiene practices, such as hand washing; showering; changing clothing; and limiting eating, drinking, and smoking during activities involving lead can protect individual health.

Defining a proactive Army-wide strategy for lead will not be a simple task. The Army does not have reliable information on the full extent of lead exposure by Army personnel, the pathways of lead contamination, and the location of lead containing materials throughout the Army. Various data-management efforts may help to overcome this problem.

Should present trends continue, it seems likely that lead will come under additional regulation from a variety of sources, including environmental, health, pollution prevention, and tax legislation. New technologies promise to produce materials which can be effective substitutes for lead, although probably at a greater initial cost. As the problems with leaded paint and lead in drinking water are resolved, regulatory, activist, commercial, and legislative attention may likely turn to other sources of lead exposure.

While the rate at which present trends could continue is likely to be variable, the most prudential, cost-effective, long-term policy for the Army appears to be a move to a policy of eliminating lead where technically and economically feasible combined with expanded hazard reduction. Given this conclusion, see the next section for specific policy recommendations.

5.2 *Specific Recommendations*

Table 5- 1 presents specific policy recommendations. The recommendations listed in the table are discussed in the remainder of this section.

Table 5-1. Specific Recommendations

	Provide Leadership
*	Provide commanders information on lead hazards
*	Consider lead to be a user problem, not an environmental problem
*	Educate the Army about lead hazards
*	Assign MACOMS specific responsibilities for lead hazard reduction
	Create a Management Strategy
*	Organize for lead-hazard management
*	Designate a single point of contact at installation, MACOM, and HQDA level
*	Adopt a team approach to reducing and eliminating lead hazards
*	Involve all with ammunition responsibility
*	Create a life-cycle policy for small arms ammunition
	Set Priorities
*	Identify the most hazardous uses of lead
*	Identify, quantify, and regulate high priority uses of lead
	Collect Information

Table 5-1. Specific Recommendations (continued)

*	Compile all policy guidance, program information, laws and regulations, and technical information into a single publications or set of publications
*	Identify uses of lead
*	Improve information management
*	Expand and improve the HHIM
*	Obtain information from other sources
*	Include GOCO information
*	Expand use of the Medical Information Module (MIM)
Exploit Existing Command and Control Assets	
*	Integrate with pollution prevention programs
*	Develop a single contract for lead projects
*	Audit lead management programs
*	Provide training in Army schools
*	Integrate lead-exposure control with safety and environmental programs
*	Integrate lead-exposure control with the Army Communities of Excellence (ACOE) Program
Seek Long-term Solutions	
*	Initiate an aggressive R&D and technology transfer effort to find substitutes for lead
*	Procure safer lead-acid batteries
*	Eliminate lead uses where feasible
Apply Lessons Learned to Other Hazardous Materials	
*	Identify areas for future study

5.2.1 Provide Leadership

Provide commanders information on lead hazards. The key to a successful lead-hazard management program is command support. Military commanders, especially installation commanders, need summarized information explaining the problems associated with lead and possible solutions to those problems. The Army should consider creating a one or two page commander's guide to lead hazard abatement and making it available to commanders at all levels. The executive summary of this guide could be used for commanders.

Consider lead to be a user problem, not an environmental problem. Those using lead to accomplish assigned missions should be responsible for controlling lead exposure. This will require systematic changes beyond the authority and capability of the Army

environmental staff. Making lead-exposure control the users' responsibility places responsibility with those who have both the ability and resources to control lead exposure.

Educate the Army about lead hazards. Many simple, proven techniques exist to protect human health and the environment from lead hazards. Using existing command and public information channels, Army members should be provided information bout lead hazards and ways to protect themselves from lead hazards. By providing this information, pollution prevention efforts and other Army programs to reduce or eliminate lead use may enjoy more widespread support. Education can play a significant role in further reducing exposure to lead hazards; reduced exposure can help reduce the costs associated with lead use.

Assign MACOMS specific responsibilities for lead-hazard reduction. As part of an integrated Army approach to reducing or eliminating lead hazards, the Army may want to consider assigning MACOMs and DA staff elements with responsibility for specific aspects of the program. These could include:

- FORSCOM: Reduction or elimination of lead exposure resulting from weapons' firing at outdoor firing ranges and during weapons' maintenance.
- TRADOC: Reduction or elimination of lead exposure resulting from weapons' firing at indoor firing ranges. (This is already a TRADOC responsibility which could be expanded.)
- U.S. Army Personnel Command (PERSCOM): Establish a tracking system to identify soldiers occupationally exposed to lead.
- MEDCOM: Expand responsibility for medical surveillance of soldiers and civilian employees occupationally exposed to lead.
- MTMC: Reduction or elimination of transportation-specific lead hazards.
- AMC: Develop modified or new industrial processes which eliminate lead, reduce its use, or contain it.
- Deputy Chief of Staff for Logistics (DCSLOG): Create procedures to reduce the acquisition of lead-containing materials, supplies, and equipment to the greatest extent possible.

5.2.2 Create a Management Strategy

Organize for lead-hazard management. In its approach to lead-hazard management, the Army should consider adopting these organizational principles:

- Designate a single point of contact at installation. MACOM, and HODA level. Currently, responsibility for managing the hazards associated with lead is dispersed among medical, occupational health, industrial hygiene, safety, legal, and environmental staff at installations and MACOMS, and research staff in various locations. Efficient and effective administration of the program could be greatly enhanced by having a single representative responsible for the lead program at each organizational level and a single research manager responsible for eliminating or reducing lead hazards.

- Adopt a team approach to reducing and eliminating lead hazards. For historical, technical, legal, and organizational reasons, various installation agencies have been assigned or have assumed responsibility for various programs associated with lead. A unified, team approach at the installation would enable installations to approach lead-hazard issues with a strong, interdisciplinary team. This team should include representatives of the operational, industrial hygiene, occupational health, medical, safety, environmental, legal, logistical, and engineering staff at each installation and MACOM.

Involve all with ammunition responsibility. Ammunition is one military commodity known to present health hazards. The Army operational, training, procurement, occupational health, R&D, and environmental communities, as well as the other Services; the DOD, other Federal agencies [such as the Central Intelligence Agency, Department of Energy (DOE), and Federal Bureau of Investigation (FBI)]; and the private sector, including law enforcement organizations and industry representatives, should create an integrated approach to developing a unified Federal policy on lead in ammunition. Ammunition crosses numerous organizational lines within the Army; policy development should include all who have responsibility for ammunition. Since the Army is responsible for small arms ammunition for all the Services, it seems appropriate that the Army take the lead in this area.

Create a life-cycle policy for small arms ammunition. This policy should be directed towards minimizing or eliminating the health and environmental lead hazard in ammunition. This policy could consider a four-fold approach: 1) reducing the amount of ammunition expended, 2) reducing the amount of lead released from ammunition, 3) eliminating lead from ammunition, and 4) designing lead-free ammunition for

training, which may not meet combat requirements but which is suitable for training. The creation of a life-cycle policy for ammunition should be conducted concurrently with a review of policy for design and operation of firing ranges, resulting in an integrated procurement, training, and operational policy. The policy should protect human health and the environment from lead hazards and meet operational and training requirements.

5.2.3 Set Priorities

Identify the most hazardous uses o f lead. Further study of lead use is required to determine the most hazardous uses of lead, those uses of lead which are most amenable to substitution, and those uses which present little threat to human health. There may or may not be a correlation between the amount of lead used and its effect on health. Detailed research is needed so Army resources are carefully targeted against real hazards. Initial investigation indicates that the eliminating battery post repair and eliminating or containing lead used in indoor firing ranges are ways to reduce hazardous exposure. More research is needed to assess the hazards to those firing and cleaning weapons as part of training exercises.

Identify, quantify. and regulate high priority uses o f lead. Lead has properties which make it a highly useful, inexpensive, and safe substance in certain applications, including lead shielding used in aprons to protect patients undergoing X-ray treatment, in the shielding in the walls in X-ray rooms, and the lead contained in lenses in night-vision devices. These uses of lead exploit the characteristics of lead without presenting a risk to the environment or human health. These uses should be identified, so that materials are managed and placed within an effective disposal system when the material is no longer serviceable.

5.2.4 Collect Information

Compile all policy guidance, program information, laws a nd regulations, and technical information into a single publication or set of publications. Information about Army policy on lead is found in a variety of regulations, technical manuals, and policy letters which often reference Federal laws or Agency regulations. Program administration would be made much easier if all information was combined into a single publication. Further, a single Army agency should be made responsible for revising and updating the publication.

Identify uses o f lead. Lead is widely used in many ways; the Army would benefit from more extensive inventories of lead in its installations and equipment. All

MILSPEC should be searched to identify lead uses; as well, installations should maintain precise inventories of the locations and uses of lead. The objective of an inventory effort ought to be the identifying likely locations and uses, rather than detailed, 100 percent inventories.

Improve information management. The DA should expand and refine its efforts to determine the full extent of exposure to lead and the uses and likely locations of lead at all its installations. Both these steps should proceed concurrently. A single Army agency, probably DCSLOG, should be responsible for creating a master list of lead containing supplies and equipment used by Army installations; this list should be compared to the numbers of the MOSs of soldiers likely to use the information.

Expand and improve the HHIM. The HHIM is an effective method for collecting and organizing data about lead exposure, Listed below are suggested ways to increase its value.

❖ Not enough industrial hygiene information is available to the Command Structure through the HHIM, making risk assessment tasks difficult. All installations should provide industrial hygiene sampling data to the HHIM database. A review of the information available from HHIM indicates that data are collected but kept at the originating installation. Sharing the data will allow better allocation of occupational health resources. This will improve Army-wide risk assessments that describe and prioritize the risks of specific operations, specific MOSs, or individual installations. Increased and/or mandatory reporting will speed hazard recognition at all individual bases. For example, when one installation discovers a task that results in an unexpected exposure, other installations can be quickly notified of the potential hazard.

❖ The HHIM does not link the MOS or CJC with the operation presenting the hazard. The system links a specific operation (e.g. Battery Post Repair) with a specific hazard (e.g., lead exposure), but the MOS or CJC of the worker exposed to lead is not recorded. The MOS or CJC should be recorded for each item of industrial hygiene sampling data generated at the installation level. The type of operation a worker performs (e.g., grinding) is currently recorded as one of the data identifiers. Risk assessments would be greatly improved if the MOS and CJC were linked to the type of operation. The HHIM could then report all MOSs and CJCs that perform tasks associated with lead exposure. Broad risk assessments could be made by assessing the number of MOSS and CJCs performing potentially hazardous tasks. Analysis of this type may reveal that a particular MOS or CJC should be placed in a medical monitoring program. Efforts should be focused on characterizing the hazards of

CJCs and not simply on MOSs alone. The Army's work force is largely civilian. These civilian personnel perform operations that have associated hazards, and they should be monitored and protected with their uniformed counterparts. During interviews, the HHIM management reported that the MOS data element is planned for inclusion in the next version of the HHIM.

Obtain information from other sources. The Army should consider other sources of lead-exposure data, such as the National Cancer Institute (NCI). NCI produces epidemiology studies of worker exposure to specific chemicals, such as lead. The studies include useful risk assessment parameters, including airborne sample results, duration of exposure, job titles with variations, and job descriptions. Many of the tasks performed in the civilian industrial sector could be matched to Army MOSs and CJCs.

Other sources of data include the OSHA industrial hygiene database, the NIOSH Health Hazard Evaluation reports, and industrial hygiene professional publications. NCI frequently uses all these sources when developing a job exposure matrix (JEM) for a specific chemical. Some existing NCI JEMs address the exposure potential to a specific chemical for every industry in the United States. Many of the industries and jobs will mirror the operations, MOSs, and CJCs of the Army.

Include GOCO information. The Army should consider including industrial hygiene data generated by contractors in its HHIM database. If the information were deemed to be reliable, a more accurate assessment of potential hazards could be made.

Expand use of the MIM. The MIM is an occupational health database that links medical screening to hazard-specific exposure data. The MIM system staff reported that the MIM is under-used due to a lack of data-entry support at the installation level. All BLL data collected at installation clinics should be reported to the MIM. The data will enable the Army to assess the effectiveness of ongoing lead hazard control measures. By funding this task or funding the development of user-friendly modular reports to be used by the installation occupational health staff, use will increase.

5.2.5 Exploit Existing Command and Control Assets

Integrate with pollution-prevention programs. By designating lead as a material which should be the focus of intensive pollution-prevention efforts, existing installation, MACOM, and DA pollution-prevention programs could be used to reduce and contain, and in some cases, eliminate lead hazards. Army pollution-prevention efforts require action at all organizational levels. By designating lead as a priority pollutant for eliminating or reducing use, those involved in pollution prevention at all levels can begin

to reduce lead use. Many pollution-prevention successes have occurred as a result of installation efforts. By making reduction or elimination policy, individuals will have organizational "permission" to institute creative, innovative techniques to eliminate pollution.

Develop a single contract for lead projects. The Army could consider developing a single indefinite delivery requirements type contract that could be used by all CONUS installations for projects such as cleaning indoor firing ranges, installing bullet traps at ranges where lead containing ammunition is fired, and for remediating lead-contaminated soil.

Audit lead management programs. The Army's ECAS should be modified to include a specific audit protocol for lead abatement and management. Creation of this protocol should be done is such a way that it is fully integrated into the 1383 process; should DOD adopt a single audit protocol, the Army should recommend that a protocol for lead be included or create one of its own.

Provide training in Army schools. Soldiers and civilian employees attending Army schools at all levels should be provided general information about lead hazards and Army policies and programs for lead-hazard management. The type and content of training should be vary, depending on the school and its mission. Training should complement and be integrated with other training on environmental management and pollution prevention. Special attention should be given to instruction conducted at the Army Management Staff College for officers selected to become garrison commanders.

Training in lead hazards, because of its health and environmental risks, should be integrated with general instruction on pollution prevention. Soldiers, especially those with responsibility for working with lead or lead-containing material, should be provided instruction on safety, health, and environmental aspects of lead use.

Integrate lead -exposure - control with safety and environmental programs. Army efforts to reduce or eliminate lead hazards should be combined efforts of safety and environmental staff at all organizational levels. By viewing lead as a medical, safety, environmental, and material issue, a more effective program can be created (Weaver-Holden, 1994).

Integrate lead-exposure control with the ACOE Program. The ACOE Program is a positive, proactive, and highly successful program intended to create excellence in installation management. By adding, as a component of installation evaluations, an assessment of the installation's efforts to become "lead-free," installation commanders and staffs would have a positive incentive to establish installation programs to eliminate lead.

5.2.6 Seek Long-term Solutions

Initiate an aggressive R&D and technology transfer effort to find substitutes for lead. Initiatives are already under way within the Army to find suitable substitutes for lead solder and for lead in ammunition. These efforts could be expanded and accelerated. The Army should explore the possibility of cooperative agreements and partnerships with private industry to accelerate the development of new technologies and processes. Army policy should be one of close integration and coordination with civilian sector R&D and technology transfer programs.

The elimination of lead hazards should become a permanent feature of environmental R&D programs. DOD, Army, and private sector research efforts should be coordinated to eliminate the most hazardous exposures to lead as soon as possible.

DOD and Army efforts to find substitutes for lead could contribute to broader national pollution prevention efforts. An R&D or technology transfer effort to locate lead substitutes should be viewed not solely as a DOD effort, but as a Federal effort. This would probably require one agency to function in a leadership role but could result in considerable economies and efficiencies in the effort to find substitutes. While leading this effort may be beyond the capability of the Army, it may be appropriate for DOD. DOD could request that the National Defense Center for Environmental Excellence initiate a project to coordinate and support existing lead substitution efforts.

Finding substitutes for lead should be viewed as part of a larger effort to develop better materials for military use. Future policy development should consider a materials policy. DOD should consider a review of all hazardous material and establish material

substitution as a way of both fielding better material for military use, as well as less hazardous material.

Procure safer lead-acid batteries. Private sector initiatives are ongoing to produce safer, more efficient lead-acid batteries which contain a jelled electrolyte and which are sealed. Army participation in these efforts could help accelerate the fielding of batteries which require less maintenance, thus posing a reduced hazard since batteries present a hazard both from the acid and lead they contain. Research efforts should be aimed at reducing both hazards (Rand, 1994).

Eliminate lead uses where feasible. Lead is coming under increasingly stringent regulation. The cost of complying with regulations on lead is bound to increase, especially if new reporting, auditing, record keeping, certification, monitoring, and medical surveillance requirements are mandated by law or adopted by the Army as the result of new information about lead hazards.

Concurrent with efforts to determine the full extent of exposure to lead, the Army should establish, as a policy direction, the eventual elimination of lead use, with the exception of high priority uses. This policy should be promulgated quickly to facilitate immediate action to control or eliminate lead use. More long-term studies could be initiated to determine the feasibility of the elimination of lead from ammunition, the development and acquisition of lead-acid batteries designed to eliminate the need to repair battery posts, and the phase out of lead in equipment paints and solders.

5.2.7 Apply Lessons Learned to Other Hazardous Materials

Identify areas for future study. There are a variety of other heavy metals used in military applications which exhibit toxicity and may present health hazards to the Army work force. These include cadmium, and other elements, such as antimony, beryllium, hexavalent chromium, mercury, silver, and zirconium. The mission-area approach used for this guide could be used to identify exposure hazards and control strategies for these materials as well. This would provide a holistic approach to controlling, eliminating, or reducing the health hazards from heavy metals to the Army's work force.

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Appendix A

Health Effects of Lead Exposure

Health Effects of Lead Exposure in Adults

Lead poisoning was one of the first recognized occupational related diseases. The object of an Army lead-exposure control strategy must be to protect the work force from the effects of both acute and chronic lead overexposure. The effects of lead poisoning can range from irritability, loss of appetite, fatigue, and other nonspecific complaints, to damage to the nervous system, kidneys, and reproductive systems, to (in rare cases) death.

Fate of Led in the Body

Lead enters the body via inhalation and ingestion. Absorbed lead (5 percent of ingested and 50 percent of inhaled in adults) travels via the bloodstream to all of the body tissues and can produce local damage if it is present in sufficient quantities. The major portion of absorbed lead is stored in the skeleton, with lead also depositing in the liver, spleen, lungs, and kidneys. As exposure to lead continues, the amount stored or “body burden’’ is likely to increase because the body has a very limited capacity to excrete it. Lead in soft tissues can slowly cause irreversible damage, first to individual cells, then to organs and whole body systems.

Acute Lead Poisoning

Acute lead poisoning is rare but may occur, especially in children, following ingestion of lead or lead compounds. Initial symptoms of acute poisoning include thirst, nausea, vomiting, and circulatory collapse. In the several days following ingestion, muscular weakness, acute hemolytic crisis, and kidney damage may occur, resulting in death in some cases. The symptoms of chronic lead poisoning are likely to occur if the patient survives.

Chronic Lead Poisoning

Chronic overexposure to lead may result in severe damage to the blood-forming, nervous, urinary, and reproductive systems. Some common symptoms include loss of appetite, anxiety, constipation, nausea, fatigue, insomnia, headache, fine tremors, and hyperactivity.

Damage to the central nervous system (including the brain) may be one of the most severe forms of lead poisoning. Lead can cause encephalopathy - a degenerative disease of the

brain. The most severe, often fatal form of encephalopathy may be preceded by irritability and convulsions.

Kidney disease associated with lead exposure has few, if any, symptoms appearing until extensive and most likely permanent damage has occurred. When overt symptoms of urinary dysfunction arise, it is often too late to correct or prevent worsening conditions and progression to kidney dialysis or death is likely.

Chronic overexposure to lead impairs the reproductive systems of both men and women. Overexposure to lead may result in decreased sex drive, impotence and sterility. Children born of parents one of whom were exposed to excess lead levels are more likely to have birth defects, mental retardation, behavioral disorders or to die during the first year of childhood.

Health Effects of Lead-Exposure in Children

Children are more susceptible to the effects of lead than adults. Risks to children and fetuses include:

- ❖ Loss of IQ, learning disabilities, behavioral problems associated with blood levels far below those considered to significantly affect the health of adults.
- ❖ Higher sensitivity to neurological effects because of developing nervous systems.
- ❖ Absorption or higher percent of ingested lead than adults.
- ❖ Hand-to-mouth habits that increase likelihood and amount of ingestion.
- ❖ Especially high probability that early nonspecific symptoms - headache, nausea, irritability, etc., will be mistaken for “normal” minor ailments, moods, etc.
- ❖ Those effects especially pronounced in fetuses and children 6 or younger.

Appendix B

Legislation and Policies

Annex 1. Federal Laws and Regulations

The following list is a brief summary of applicable Federal statutes and citations governing lead and lead compounds:

Solid Waste Disposal Facilities: The criteria for deciding which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health or the environment are contained in 40 CFR Part 257. These criteria were adopted under the Resource, Conservation and Recovery Act (RCRA), section 1008(a)(3) and 4004(a). Appendix I to 40 CFR 257 contains the maximum contaminant levels (MCLs) for use in determining whether solid waste disposal activities comply with the ground-water criteria of 40 CFR 257.3-4. The MCL for lead is 0.05 milligrams per liter (mg/L) parts per million (ppm).

Hazardous Waste: Lead is listed as a "Toxicity Characteristic" hazardous waste under the RCRA regulations promulgated in 40 CFR 261. In 40 CFR 261.24, a solid waste exhibits the characteristic of toxicity if, using the Toxicity Characteristic Leaching Procedure (TCLP) test (40 CFR 261, App. II), the extract from a representative sample of the waste contains $\geq$5.0 mg/L (ppm) of lead. A hazardous waste meeting these criteria has an EPA hazardous waste number of D008. If a hazardous waste that contains lead is placed into or onto a land treatment facility, the concentration of lead must be determined through analysis according to 40 CFR 265.273. Lead is also listed as a hazardous constituent in 40 CFR 261, App. VIII.

Hazardous Substance: Lead is designated as a hazardous substance under the Comprehensive Environmental Response, Compensation, and Liability Act; the List of Hazardous Substances and Reportable Quantities appears in 40 CFR 302.4. The reportable quantity for lead where the diameter of the pieces of solid metal released is less than 100 micrometers (μm) (.004 inches) is 10 pounds. Reporting for lead is not required where the diameter of the pieces is equal to or greater than 100 μm (.004 inches).

Air Quality Standards: Lead is a primary and secondary ambient air product under the Clean Air Act regulations promulgated in 40 CFR 50. The national primary and secondary ambient air quality standards for lead and its compounds listed in 40 CFR 50.12 are: 1.5 micrograms per cubic meter ($\mu g/m^3$), maximum arithmetic mean averaged over a calendar quarter. The requirements for preparation, adoption, and submittal of State implementation plans are contained in 40 CFR 51. The requirements for developing control strategies for the attainment and maintenance of national air quality standards are contained in 40 CFR 51, Subpart G.

Standards of performance for lead-acid battery manufacturing plants are contained in 40 CFR 60, Subpart KK. Regulations concerning fuels and fuel additives are located in 40 CFR 8O; this includes regulations that specifically address lead-additive manufacturers. The test methods for lead in gasoline are contained in 40 CFR 8O, Appendix B.

Effluent Guidelines and Limitations: Effluent limits are in place for lead under the Clean Water Act. These limits are process-specific and are contained in the Effluent Guidelines and Limitations regulations in 40 CFR 401. Discharge limits for lead in the Electroplating of Common Metals Subcategory are listed in 40 CFR 413.10-14. Discharge limits for lead in the Secondary Lead Subcategory are listed in 40 CFR 421.130-136. Discharge limits for lead in the Lead-Tin-Bismuth Forming Subcategory are listed in 40 CFR 471.l0-16. Discharge limits for lead in the Metal Powders Subcategory are listed in 40 CFR 481.100-106. Lead is also listed as a Table III Toxic Pollutant in 40 CFR 122, Appendix D.

Drinking Water Standards and Regulations: The use of lead in drinking water systems is prohibited under the Safe Drinking Water Act regulations promulgated in 40 CFR 141, Subpart E. The MCL for lead in drinking water is listed in 40 CFR 141.11(b) as 0.05 mg/L (ppm). The final action level was promulgated on June 7, 1991, in No. 110, Volume 56, p. 26478 Federal Register (56 FR 26478). The final action level is exceeded if the level of lead in more than 10 percent of the targeted samples is greater than 0.015 mg/L (90th percentile). Lead is listed in 40 CFR 141.51 as having an MCL goal of 0.0 mg/L (ppm) for inorganic contaminants. Any pipe, solder, or flux used in the installation of any public water system or any plumbing in a residential or nonresidential facility that provides water for human consumption which is connected to a public water system must be lead free (this does not apply to leaded joints necessary for the repair of case iron pipes) pursuant to 40 CFR 141.43. Fluxes and solders containing no more than 0.2 percent lead and pipe and pipe fittings containing not more than 8.0 percent lead are defined as “lead free.” The national primary drinking water regulations for lead are contained in 40 CFR 141 .80-91. This includes “action levels” for lead, corrosion-control measures, lead service-line requirements, public education and supplemental monitoring requirements, monitoring requirements for lead in tap water, monitoring requirements for lead in source water, and reporting and record keeping requirements.

LBP Poisoning Prevention: The seven-fold purpose of Title X is to:

1) Develop a national infrastructure to efficiently eliminate LBP hazards.

2) Establish a program based on priority to evaluate and reduce LBP hazards in the nation’s housing stock.

3) Establish a workable plan for LBP hazard evaluation and reduction.

4) Ensure LBP hazards are accounted for in government policies addressing housing sales, rentals, and renovations.

5) Mobilize national resources efficiently.

6) Reduce the threat of childhood lead poisoning in housing owned, assisted, or transferred by the federal government.

7) Educate the public on the hazards associated with LBP.

Lead-containing Paint: Under sections 8 and 9 of the Consumer Product Safety Act, paint and similar surface-coating materials for consumer use that contain lead or lead compounds where the lead content (calculated as lead metal) is more than 0.06 weight-percent of the total nonvolatile content of the paint or dried paint film, are banned hazardous products. The regulations banning lead paint are located in 16 CFR 1303 and 16 CFR 1500.17.LBP Poisoning Prevention Act prohibits the use of LBP in residential structures constructed or rehabilitated by the Federal Government or with Federal assistance in any form. This prohibition is promulgated at 41 CFR 114-25.351.

Work Place Exposure Limits: Under the OSHA, an employee's exposure to airborne lead is limited according to the regulations contained in 29 CFR 1910.1025. This section applies to all occupational exposures, except for those that occur in the construction industry and agriculture operations. Under this section, the highest level of lead that an employee may be exposed to is 50 $\mu g/m^3$, averaged per an 8-hour work day. This section also prescribes respiratory protection standards and requirements, protective work clothing and equipment standards and requirements, housekeeping standards, hygiene facilities and practices standards, medical surveillance requirements, employee information and training standards, decontamination procedures, and sign and posting requirements.

Work place exposure limits are established for the construction industry in 29 CFR 1926.62. The permissible exposure limit (PEL) set in this section matches that of the general industry lead standard described above (50 $\mu g/m^3$). This section also prescribes exposure assessment and compliance methods, respiratory protection and PPE requirements, housekeeping standards, hygiene facilities and practices, medical surveillance, training, signs, and record keeping.

Use and Disposal of Federal Property: The regulations controlling the use and disposal of hazardous materials and certain categories of property are promulgated in 41 CFR 101-42. The regulations that specifically address lead-containing paint and items bearing lead- containing paint are found in 41 CFR 101-42.1102-7. Regulations that address ammunition components, including bullets, and scrap-ammunition components are located in 41 CFR 101.42.1102-8(d)(3)

& (4). Disposal of Federal facilities under Base Realignment and Closure (BRAC) actions that may be used for residential occupancies is subject to Title X, Section 1013.

Transportation: The transportation of lead compounds is regulated under the Hazardous Material Transportation Act (HMTA) by the U.S. Department of Transportation. The transportation requirements for specific lead mixtures and compounds are contained in the Hazardous Materials Table located in 49 CFR 172, Subpart B.

Metallo-organic Pesticides and Containers: Disposal of metallo-organic pesticides, pesticide residues, and pesticide containers that contain lead are regulated under 40 CFR 165, Subpart C.

Lead Fishing Sinkers: The EPA proposed a rule under the TSCA, section 6(a), to prohibit the manufacture, processing, and distribution in commerce in the United States of certain smaller size fishing sinkers containing lead and zinc, and mixed with other substances, including those made of brass. The proposed rule was published on March 9, 1994 (see 59 FR 11122). The comment period for this proposed rule expired on July 8, 1994.

LBP Certification Program: This EPA proposed rule under Title IV, section 402(a)(1) of the TSCA would establish training requirements, would require certification of training programs, and would require all LBP activities be performed by certified individuals. The proposed rule was published on September 2, 1994 (see 59 FR 45872). The comment period expired on November 1,1994.

Significant New Uses of Lead: This EPA advance notice of proposed rulemaking under Section 5(a)(2) of the TSCA is examining potential regulation of new uses of lead. These proposed rules would regulate lead in five use classes: water conveyances, products commonly used around the home, products that could be mouthed by children, products that release lead to the environment through weathering, and products where use necessarily results in uncontrolled release to the environment. The comment period expired on November 28, 1994.

EO 12856, Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements, August 4,1993: This order requires the head of each Federal agency to develop voluntary goals to reduce the agency's total release of toxic chemicals to the environment and off-site transfers of such toxic chemicals for treatment and disposal from facilities covered by the order by 50 percent by December 31, 1999. To the maximum extent practicable, such reductions shall be achieved by implementing source reduction practices.

EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, February 16, 1994: This order requires the EPA Administrator to convene a working group to provide guidance to Federal agencies on criteria for identifying

disproportionately high and adverse human health or environmental effects on minority populations and low-income populations. The order contains requirements for Federal agency research and record keeping on environmental hazards affecting minority and low-income populations, and requires each agency to create an environmental justice strategy.

The Lead Exposure Reduction Act of 1991: This Act passed the Senate and was pending before the House of Representatives in the 103rd Congress. If passed in a future Congress, this Act will, among other things, impose additional restrictions on the lead content of various materials, require an inventory of lead-containing products, regulate the disposal and recycling of lead-acid batteries, establish national centers for the prevention of lead poisoning, and standardize State reporting of BLLs.

If enacted, this legislation will create additional management requirements for the Army. The extent and cost are difficult to predict. As a major consumer of lead, the Army will likely face many new requirements. However, certain Army efforts, such as AMC's project to research all MILSPECs to determine where lead is being used, and USACHPPM's (formerly USAEHA's) data management projects should help the Army move quickly to comply with this legislation.

The Lead Abatement Trust Fund Act of 1993: Introduced by Senator Bradley (D-NJ), this Act would impose an excise tax on lead and lead products and would create a program under which States and certain local governments would receive grants from the Trust Fund. This Act would amend the Internal Revenue Code to impose a tax on "lead removed from any United States smelter" and on "lead in any taxable lead product entered into the United States for consumption, use, or warehousing." Revenue collected through the excise tax would be available for expenditure on grants "for the purpose of evaluating and reducing LBP hazards according to Title X of the Housing and Community Development Act of 1992." This bill has been referred to the Committee on Finance for consideration and may be reintroduced in the next session of Congress (Peters, 1994).

Federal and Postal Service Employees OSHA (HR115): Introduced by Representative Clay (D-MO), this bill would have allowed Federal agencies having responsibility for enforcing OSH regulations to fine Federal facilities up to $7000 per day for regulatory violations.

None of these three Acts passed in the last Congress, and their fate in future sessions is unknown. However, this legislation, introduced by different legislators with different objectives, seems to indicate a growing Congressional desire to limit exposure to lead using a variety of mechanisms.

Annex 2. DOD Policies and Guidance for Lead

This list contains summaries of DOD policy and guidance documents related to occupational exposure to lead.

DOD Directive 1000.3. Safety and Occupational Health Policy for the Department of Defense. This directive provides for implementation within DOD of applicable PLs, EOs, and Government regulations concerning safety and occupational health. Its provisions establish the basis for all DOD safety, fire protection, and occupational health programs.

DOD Directive 4210.15, Hazardous Material Pollution Prevention. DOD policy to select, use, and manage hazardous material over its life cycle so that the DOD incurs the lowest cost required to protect human health and the environment. This directive places emphasis on source reduction, or less use of hazardous material in processes and products, rather than "end-of-pipe'' management.

DOD Directive 6055.1, DOD Occupational Safety and Health Program. This directive establishes the DOD OSH program, implements the OSHA of 1970, and provides for a system of alternate or supplementary standards for military-unique OSH problems. The Army and Air Force Exchange System is included in the definition of the DOD. This directive establishes the requirement for "comprehensive, aggressive OSH programs" as DOD policy and specifies a multidisciplinary team approach to safety and health management.

DOD Directive 6055.5, Industrial Hygiene and Occupational Health. Broad in scope, this directive establishes uniform procedures to recognize and evaluate health risks associated with exposure to chemical, physical, and biological stresses in DOD work places. DOD requires its components to establish medical surveillance programs and requires the Under Secretary of Defense (Acquisition) to assess the effects and impacts of specific environmental conditions, unique to the military, on personal health and well being.

DOD Instruction 6050.5, DOD Hazard Communication Program. DOD policy is to protect DOD personnel from the adverse effects of work place hazardous materials and waste and to reduce the number of chemically related injuries and illnesses. This instruction establishes a standardized Hazardous Materials Information System according to 29 CFR 1910.

DOD Memorandum, SURJECT: LBP (LBP) - Risk Assessment, Associated Health Risk in Children, and Control of Hazards in DOD Housing and Related Structures, November 24, 1992. Establishes DOD policy to provide occupants of DOD housing and related structures (to include leased housing) a safe and healthful environment. DOD will assess and correct all recognized health hazards in DOD housing and related structures and will negotiate for assessment and control of LBP in DOD-leased facilities.

DOD Memorandum, SUBJECT: Asbestos, Lead Paint, and Radon Policies at Base Realignment and Closure Properties, October 31,1994. Facilities disposed of under BRAC actions that may be used for residential occupancy must comply with most stringent requirements of Title X, Section 1013, State, interstate, and local laws and regulations, taken together.

DOD Memorandum, SUBJECT: Modification of Pediatric Blood Lead Screening Program, June 26, 1995. Universal screening may be suspended at a medical facility if the prevalence of elevated BLL cases is under 2 percent, based on a number of children tested that constitutes a representative sample from which a reasonable statistical inherence may be drawn about the entire population.

Lead: A Quick Reference Guide to the Industrial Hygienist, DOD Interagency LBP Task Force, April 1995. This document is intended to provide a summary of lead regulatory requirements as they relate specifically to the duties of the industrial hygienist. The goal of this publication is to identify and alert the industrial hygienist of current or forthcoming requirements

It is DOD policy to follow the regulations established by OSHA or the regulations established by the American Conference of Governmental Industrial Hygienists, or other Federal standards setting guideline groups,. such as NIOSH, whichever is more stringent.

U.S. Army Environmental Hygiene Agency (USAEHA) Technical Guide No. 198, A Commander's Guide to Childhood Lead Poisoning Prevention/Lead-Based Paint Management Program on DOD Installations, June 1993. Guidance for establishing programs that recommends formation of an installation lead hazard management team.

Annex 3. DA Policies and Guidance for Lead

The following is a summary of DA policy and guidance documents related to occupational exposure to lead.

AR 40-5, Preventive Medicine. This regulation establishes a comprehensive program to protect the health of Army personnel and the environments in which they work. It establishes an Army Occupational Health Program for both field operations and the industrial work place. The Army's program places emphasis on both preventing exposure and monitoring those potentially exposed to hazards. The regulation currently does not specifically address lead; however, Army programs to monitor the health of Army personnel exposed to lead are conducted under the provisions of this regulation. AR 40-5 is being revised to include a section specifically on lead. This is the primary policy document intended to implement programs to protect human health from toxic materials.

AR 40-10, Health Hazard Assessment Program in Support of the Army Material Acquisition Decision Process. The objective of this program is to identify and eliminate or control health hazards associated with the life-cycle management of Army equipment. Toxic chemicals are one of a variety of hazards considered. This regulation provides a doctrinal foundation for life-cycle management of lead in Army equipment.

AR 200-1, Environmental Protection and Enhancement. This comprehensive regulation provides extensive guidance on all aspects of the Army's environmental program. Lead is addressed as a regulated contaminant in drinking water but not as a separate program. The regulation establishes as Army policy the reduction of the generation of hazardous waste. This regulation is being revised to prohibit the use of all applications of LBP. More detailed guidance will be published in a new DA PAM 200-1.

AR 385-10, The Army Safety Program. This regulation establishes a comprehensive safety program for all DA personnel and operations worldwide. This regulation implements OSH regulations within the Army.

AR 420-70, Buildings and Grounds. This regulation prescribes the policies and standards for facility engineering responsibilities for buildings and structures, specifically stating that lead-containing paint not be used. This regulation is being revised.

Headquarters, Department of the Army Letter, March 26, 1993, SUBJECT: Inspection and Evaluation of U.S. Army Indoor Firing Ranges. This letter contains DA policy for the safe operation of indoor firing ranges. It is specifically written to address lead hazards.

Technical Bulletin, Medical 503, The Army Industrial Hygiene Program, February 1985. This document provides specific guidance for systematic evaluation of potentially hazardous industrial operations to ensure the elimination and control of occupational health hazards, including exposure to lead. Installation commanders are responsible for implementing these programs.

Technical Bulletin 420-70-2, Installation Lead Hazard Management (Draft). This handbook is being written to assist installations in addressing leaded paint, lead-containing dust, and lead-contaminated soil.

Technical Manual 9-6140-200-14, Operator's, Unit, Intermediate Direct and Intermediate General Support Maintenance Manual for Lead-Acid Storage Batteries, July 1989. This manual contains technical information for battery maintenance. It provides very specific, detailed information on safety and medical aspects of battery maintenance operations. Although not intended to be a policy document, this manual recognizes and provides explicit instructions on the problem of take-home lead, thus establishing the basis for a DA policy on take-home lead.

Department of the Army, Memorandum, DAM-FDF-B, SUBJECT: Policy Guidance - Lead-Based Paint and Asbestos in Army Properties Affected by Base Realignment and Closure, November 5, 1993. This memorandum provides Army policy guidance on identifying and eliminating LBP and asbestos hazards in BRAC actions.

Department of the Army, Memorandum, DAM-ED-C, SUBJECT: Lead-Based Paint Contaminated Debris -- AEHA Guidance, March 29, 1994. This document provides guidance on the disposal of whole-building demolition debris and small-scale debris which are contaminated with lead.

Department of the Army, Memorandum, HSHB-ME-SH, SUBJECT: Compliance with Executive Order 12856, July 1, 1994. This letter contains draft instructions for responding to EO 12856. EO 12856 requires a 50 percent reduction in total releases of toxic chemicals or toxic pollutants to the environment and off-site transfers of such toxic chemicals by 1999 using 1994 baseline data. Lead has been specifically identified as a toxic release inventory chemical of interest.

Department of the Army, Memorandum, ASAILLE, SUBJECT: Lead-Based Paint Policy Guidance, April 28, 1993. Army facilities and environmental policy and guidance for identification, assessment, in-place management, removal, and disposal of LBP and lead-contaminated dust. This policy is currently being revised and will be replaced by a new AR 420-70.

Department of the Army, Memorandum, SAPS-PSP, SUBJECT: Childhood Lead Poisoning Prevention, May 26, 1993. Army medical policy and guidance. Each medical facility will form a team to administer direct screening using a risk-factor questionnaire, universal blood testing at 12-month well-baby visits, and elevated BLL case investigation and management. The team is intended to support installation-wide lead-hazard management teams, including outreach and education activities. This policy is currently being revised.

Headquarters, Department of the Army, Letter 200-94-1, January 19, 1994, SUBJECT: Army Pollution Prevention Program. This letter establishes policies and assigns responsibilities for management of the Army pollution prevention program. It creates a comprehensive, integrated, long-term pollution-prevention program intended to transition the Army from pollution control to pollution prevention.

Technical Bulletin, Medical 502, Occupational and Environmental Health Respiratory Protection Program, February 1992. This bulletin provides Army policy for installation respiratory protection programs.

Appendix C

Training and Readiness

Sources of Exposure

Training and readiness activities expose soldiers and civilian employees to lead in a variety of ways. Some of these activities are well understood; others have not been extensively researched. Primary sources of lead exposure include:

- Operation of indoor and outdoor firing ranges;
- Weapons training and maintenance;
- Operation of combat and support vehicles;
- Field maintenance operations in support of training;
- Training in demolitions and construction of field fortifications;
- Live-fire and maneuver exercises;
- Field water supplier;
- Ammunition maintenance;
- Ammunition residue procedures;
- MOS training; and
- Unauthorized or illegal activities, such as theft or modification of ammunition.

Some of these sources of exposure are secondary sources as well. For example, a primary source of exposure from the operation of vehicles would result from the handling of lead-acid batteries during routine servicing of the vehicle by vehicle crew members. A secondary source would be inhalation of lead-containing dust produced by wheeled or tracked vehicles.

Operation of Indoor and Outdoor Firing Ranges

While almost all soldiers will have some lead exposure from weapons training, soldiers and civilian employees assigned responsibility for the operation of ranges could be more heavily exposed. These would include officers and noncommissioned officers responsible for operating ranges (typically rifle, pistol, and machine gun ranges), range safety personnel, and maintenance staff responsible for maintaining ranges and repairing target systems (Liabastre, 1994). Elevated BLLs have been detected in range personnel, and indoor firing ranges remain the Army's single most significant source of lead hazards, especially for range staff and those responsible for cleaning indoor areas (Findlay, 1994; Wortley, 1994).

Range staff are exposed to lead through the inhalation of lead particles and ions released to the air from both weapons firing and the impact of projectiles on backstops in indoor firing ranges. These inhaled amounts are likely to exceed the amount inhaled by soldiers using the range simply based on the length of time range staff are exposed.

Lead can also be deposited on clothing and on the body and can be transported to others; thus, exposing others not involved in firing at indoor firing ranges to lead hazards. This is referred to as "take-home lead."

Lead Exposure from Weapons Training and Maintenance

Military ammunition and some primers used in ammunition contain lead. Soldiers firing weapons are exposed to lead from the projectile and lead styphnate typically used in primers. The primary route of exposure would be by inhalation of particulates and ions carried in gases resulting from the detonation of the primer and from the release of lead from the projectile by expanding gases resulting from the detonation of the propellant (Martinez, 1993).

Typically, military weapons require cleaning and other forms of routine maintenance. Lead deposits on the weapons are removed using a variety of solvents and cleaning methods. Soldiers and civilian maintenance staff could be exposed to lead through ingestion if they fail to wash their hands before eating, drinking, or smoking.

Lead particles can also be deposited on clothing and exposed body surfaces and then transported into vehicles and homes. This creates the possibility of exposure to the soldiers' family members and civilian employees.

Operation of Combat and Support Vehicles

Since the Army has eliminated leaded fuel use in ground transport vehicles, vehicle operations are no longer a significant source of lead released to the atmosphere. This does not mean, however, that vehicle operations do not contribute to lead exposure.

The operation of vehicles during training, particularly tracked vehicles, can create large volumes of dust, depending on soil conditions. If the soil contains lead, dust inhaled by soldiers could be a source of lead with lead levels dictated by the, amount of lead in the soil. Sources of lead in soil could include deposition from airborne pollution, contamination by ammunition or lead-acid batteries, on fill material containing lead (such as ash from coal plants, and mining wastes).

In addition to these hazards from dust, leaded fuels are still used in helicopters and in propeller aircraft. The operation of these aircraft and the handling of fuel represent a potential for lead exposure.

Field Maintenance Operations in Support of Training

While most maintenance activities are conducted in fixed facilities and will be discussed in the logistical and industrial operations sections of this guide, military units are equipped, staffed, and organized to perform certain specified maintenance activities under field conditions. These activities include repairing components of military vehicles, such as radiators and batteries, as well as the vehicles themselves.

Field maintenance operations involving lead-acid batteries present a possible source of contamination. These are mostly maintenance activities carried out by vehicle operators and crews that consist of cleaning battery posts and battery compartments, checking and filling electrolyte levels, and replacing batteries. Maintenance personnel at organizational levels may be exposed to lead, especially if they are operating under field conditions in tents, shelters, or facilities without the pollution controls and safety equipment found in fixed facilities.

Battery charging and maintenance; welding operations; and metal forming, cutting, and shaping conducted under field conditions by military units supporting training exercises may be a source of exposure if the material being worked contains lead or if lead solder is used.

Soldiers cleaning lead-acid battery terminals may be at risk, especially if they use wire brushes to remove corrosion and obtain a clean, smooth surface on the battery post to obtain a good electrical connection between the battery post and the battery clamp.

Training in Demolitions and Construction of Field Fortifications

The detonation of demolitions during training could release lead from soil thrown into the air. The construction of field fortifications can release lead from the soil, especially if the area used for training has been contaminated with lead from expended ammunition. Using demolitions to create craters for obstacles may release lead held in the soil thrown out of the crater by the explosion. In addition, if lead-containing initiators such as lead azide are used in the demolitions, the lead would be released on its detonation.

Soldiers digging individual fighting positions using hand tools may be at risk if they inhale dust containing lead. They may be further at risk if they fire weapons from these positions; not only will they inhale gases containing lead particles and ions from primers, but they may also inhale lead in dust generated by the muzzle blast of the weapon.

Live-Fire and Maneuver Exercises

Live-fire exercises, often combined with wheeled and tracked vehicle movement, could result in the soldiers' exposure to lead from a variety of sources. These include lead from weapons firing, lead released to the air in dust thrown up by vehicles and explosions, and dust and particles containing lead carried into the air by fires started by incendiary or other munitions.

Combined arms training, often involving intensive operations over a period of several days, is the training method of choice for combined arms commanders. These exercises present potentially substantial risks of exposure because they combine, in a short period of time, a concentration of several activities capable of exposing soldiers to lead.

Soldiers operating under extended periods in these exercises will become fatigued, and normal field sanitation methods, such as field showers, may not be available. This increases the likelihood of ingestion of lead while eating, smoking, shaving, or brushing the teeth. Essentially, field operations are dirty, smoky, and dusty; this increases the possibility of exposure.

Field Water Supplies

Water on most training exercises is provided to units in the field from water distribution points operated by organizational logistical units. The water is drawn usually from installation or local water systems. Given Army and municipal programs for controlling lead in drinking water, lead exposure from drinking water is likely to be negligible.

However, units training under field conditions may obtain water from other sources, including lakes and streams and temporary wells. This water is typically processed by water purification units and taken to water distribution points. This is more often performed during large exercises in remote training areas. Unless the water is tested, lead levels are unknown. The magnitude of risk is probably small, although it is possible that storm water contaminated with lead from firing ranges could find its way into aquifers or bodies of water used as sources of raw water (NCEL, 1991).

Ammunition Maintenance

Although primarily a depot level activity, some training exercises may involve ammunition maintenance. Maintenance activities could include removing rust or corrosion from tank main gun ammunition or artillery ammunition, and panting exposed surfaces. Should any of the coatings contain lead, exposure might be possible.

Ammunition Residue Procedures

Once ammunition has been expended, the empty cartridges from small arms ammunition are collected, usually by hand, consolidated, and turned into unit or installation supply elements. Handling the residue may expose soldiers to varying amounts of lead; MHE may also become contaminated. Expended ammunition casings, if stored outside, may contribute to nonpoint source water pollution if these materials are not protected from the weather.

MOS Training

Certain MOS, such as those for plumbers, may require the use of lead or materials containing lead as part of the training. When lead is melted for use in sealing joints in cast iron pipe, inhalation of vapors containing lead may be possible. Training soldiers in battery maintenance operations that involve melting lead to repair battery posts presents another source of exposure

Unauthorized or Illegal Activities

Although probably infrequent, some illegal activities conducted during training exercises may result in lead exposure. These include picking up, handling, or carrying rifle or machine gun bullets for souvenirs; detonating pyrotechnics as fireworks; theft of ammunition and vehicle batteries for personal use; burning, burying, or destroying ammunition to avoid turn-in procedures; illegally modifying ammunition; and improper disposal of lead-acid batteries.

The level of exposure to personnel participating in these activities is difficult to quantify, and determining the effects of lead exposure on human health may be impossible. However, these activities each have the potential for removing lead-containing material from Army control and placing soldiers and their families at risk. Children in homes where the parents have military bullets or munitions could handle them, thus increasing their exposure to lead.

Risk Assessment

Assessing the risk to soldiers and civilian employees from training and readiness activities is difficult. The USACHPPM program has collected exposure data for employees working in indoor firing ranges, some weapons firing, and for some logistical activities in support of training and readiness. The information focuses on operations at fixed facilities, not combined arms operations. It does not seem to capture the total number of soldiers and civilian employees engaged in training and readiness activities which may expose them to lead. Although the HHIM appears to be incomplete, in that it contains little data on weapons training, it is a good foundation for an expanded database for training and readiness, and contains the only existing information on lead exposure to soldiers and civilian employees during training and readiness activities.

By sorting the data according to RAC, as shown in Table C-1, an estimate of how many soldiers and civilian employees are potentially exposed to lead while performing training and readiness activities can be obtained.

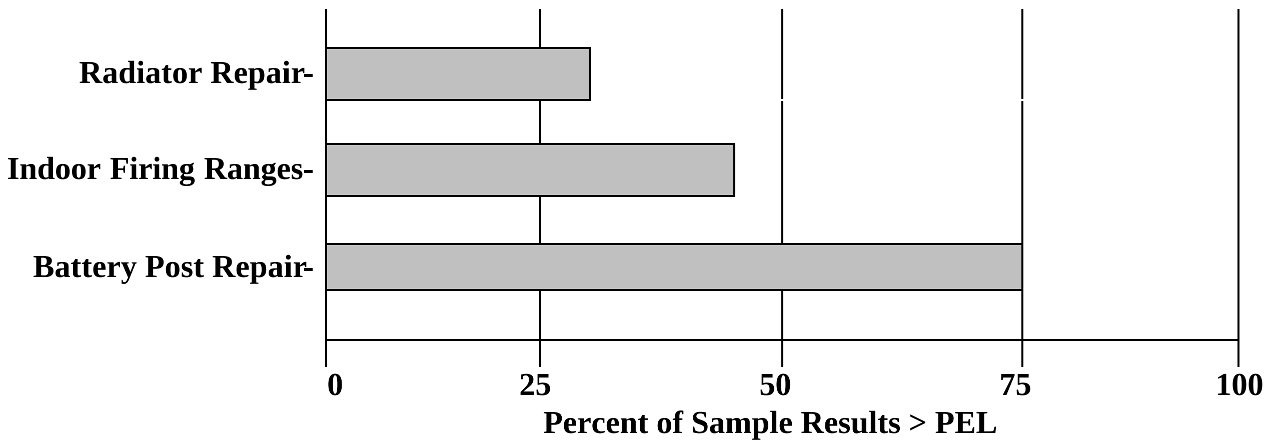
Table C-1. Exposure to Lead During Training and Readiness

	# Exposed	Males	Females	Military	Civilian	Contractor
RAC 1	58	56	2	2	56	0
RAC 2	293	284	9	92	201	0
RAC 3	601	528	73	361	240	0

Training and readiness activities and activities conducted in support of training and readiness can result in lead exposure. These activities generate airborne-lead levels well above the OSHA PEL. These sample results would be considered a violation of Federal law, depending on the engineering controls and PPE used. A review of HHIM information regarding the PPE and engineering controls used while these airborne samples were collected suggests that workers were not adequately protected from lead exposure in some instances. (Information regarding specific operations performed without adequate controls is detailed in Appendix L.)

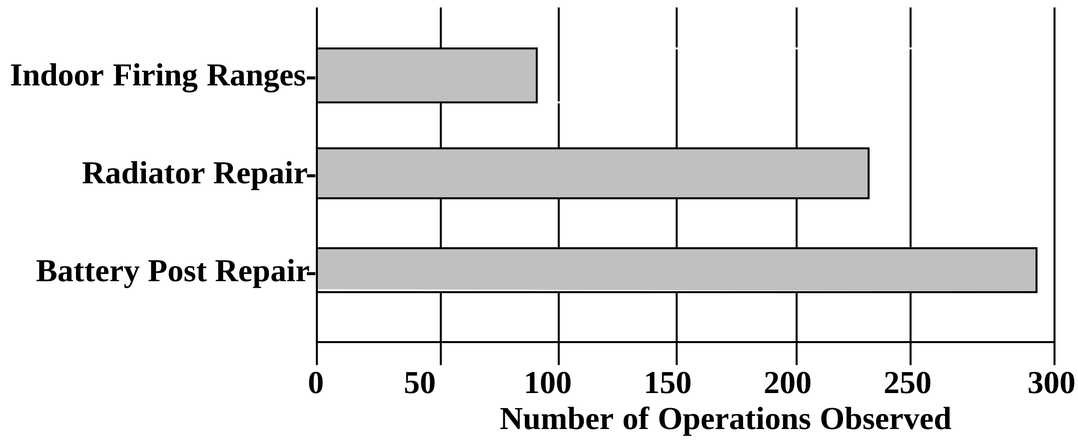
The activities selected for presentation in the graph in Figure C-1, rated with RACs of 1 (Critical) or 2 (Serious), are only a small portion of the training and readiness activities associated with lead. Other activities conducted in support of training and readiness that can result in exposure include body repair, metal sanding, brazing, and welding.

Figure C-1. Training and Readiness
Percent of HHIM RAC 1 and 2 Lead Air Sample Results
Exceeding the OSHA PEL



Although no precise estimate of the frequency with which lead-associated operations are conducted is available, the graph in Figure C-2 provides a conservatively low estimate of how often an operation occurs Army wide.

Figure C-2. Number of RAC 1 and RAC 2 Operations Observed or Surveyed Army Wide During 1994



The numerical data provided by HHIM represents surveys or observations by Army industrial hygiene staff conducted in 1994. Although lead air monitoring was not performed during each survey, the industrial hygienist specifically noted that the operation was taking place during a walk-through or more extensive type of survey. It is likely that the number of occurrences is much higher than the frequency suggested in the graph.

No numerical weighting can be performed by combining the information presented in the previous and following graphs, due to differing time periods (one year of data vs. multiple years), and the variation of control and cleanliness associated with the performance of the same task at different installations.

Assessing risk to soldiers and civilian employees engaged in training and readiness activities may involve fairly extensive testing of soils, investigating ammunition detonation characteristics, determining lead deposition patterns, and blood testing of selected soldiers and civilian employees.

Those personnel who may be at highest risk from lead exposure in training include soldiers whose duties involve, extensive firing and cleaning of weapons and vehicle maintenance under field conditions. Typically, this group includes infantry, armor, and artillery vehicle or gun crew members, but may also include others, such as engineers or military police. However, the HHIM database indicated that many operations including weapons firing were surveyed and were in compliance with the OSHA PEL. The HHIM data does not explain the conditions under which the firing occurred.

Because the HHIM provides information on only some of the activities conducted under the training and readiness mission area, the actual risks may be difficult to quantify or prioritize. Based on the information in the HHIM and in Section 4.1.2, the activities which likely present the greatest risk include operating indoor firing ranges, training at indoor firing ranges, and repairing radiators and lead-acid batteries.

Risk-Reduction Strategy - Installation Actions

Developing a risk-reduction strategy for training and readiness activities will involve a mix of control mechanisms, some relatively easy to implement, and some both difficult and possibly expensive. First, there are only limited data on exposure rates for training and readiness activities; unless additional data is developed, risk-reduction strategies will be difficult to design. Second, reducing lead levels or eliminating entirely the lead in munitions, potentially the largest primary source of exposure, may be an expensive undertaking with far reaching implications. Finally, reducing exposure will mean educating commanders, staffs, and thousands of soldiers and civilian employees Army wide.

Information gained from the HHIM database was used to guide an initial risk-reduction strategy. Specifically, the database shows that indoor firing ranges present a lead risk. Another potential hazard from training and readiness operations, exposure from lead-containing dust and soil during field operations, is not well recorded in the database. If data on soil lead levels in training areas become available, the risks of lead exposure during field activities, as well as the benefits of risk-reduction measures, can be better quantified. A third source of exposure results from firing ammunition outdoors. Because of lead use in bullets and primers, lead exposure is expected although this information is not present in the HHIM database. Additional monitoring comparing the risks from indoor and outdoor firing ranges will help quantify the risks posed by outdoor firing ranges and help determine the benefits of reducing the risks from outdoor firing ranges.

While ammunition appears to be the most significant lead problem in training and readiness, other routes of exposure should be addressed. This could include testing of soils and water in training areas to determine if lead is present and conducting research on military training to determine if soldiers are exposed to lead in soil and water.

Therefore, an Army-wide, risk-reduction strategy for this mission area should:

- Be developed jointly by all Army elements involved in readiness and training.
- Consider various combinations of containment, reduction, substitution, and elimination of lead.
- Build upon existing strategies and standards, such as the Army's program for indoor firing ranges.
- Consider both high technology and low technology solutions.

Reducing or eliminating the lead hazard from soil in training areas presents a new problem for Army training managers. The extent of the problem is unknown and is part of the larger problem of training-area management. Army installations may be required to determine and possibly abate lead levels in soil in response to both emerging State and Federal regulations.

While reducing or eliminating lead from ammunition may be difficult, some actions may be relatively easy to implement. Simply substituting existing weapons' simulators for actual weapons firing can eliminate some exposure. Closer attention to individual decontamination after lead exposure from weapons firing may reduce exposure as well.

Lead-acid batteries are used in almost all military vehicles, and their replacement with batteries not containing lead seems highly unlikely. However, a combination of inexpensive technological fixes, combined with an awareness program, could substantially reduce exposure from lead-acid batteries.

Given these constraints, installations can:

<u>Avoid lead hazards by:</u>

- Educating commanders, staffs, soldiers, and civilian employees about lead hazards and ways to avoid lead hazards.

- ❖ Ensuring that those using indoor firing ranges are aware of the problem with "take-home" lead and practice appropriate hygiene, including hand washing, showering, and changing clothing.

- ❖ Testing soils and ambient air levels during training at selected training areas to determine lead levels, and avoiding, if possible, lead-contaminated training areas.

- ❖ Requiring soldiers who are cleaning, changing, or handling vehicle batteries to use PPE and to practice appropriate personal hygiene, such as washing their hands in cold water after servicing batteries.

- ❖ Including testing for lead in field-water supply operations. If lead levels in the water exceed standards, a water purification method should be chosen to remove the lead or an alternative water source should be selected.

- ❖ Researching the full range of possible primary and secondary lead-exposure pathways to soldiers involved in training activities, or activities supporting training activities, and designing control strategies to ensure a hazard-free training environment.

- ❖ Using outdoor firing ranges rather than indoor firing ranges whenever possible.

- ❖ Consolidating battery maintenance activities at installation or general support level.

<u>Contain lead hazards by:</u>

- ❖ Expanding training-area management efforts to include more extensive efforts in planting ground cover to prevent erosion from wind and water. These efforts would benefit natural resource conservation efforts and would help reduce dust levels, thus reducing the possibility of lead exposure by inhalation.

- ❖ Limiting ground-disturbing activities in training areas to the extent possible consistent with training requirements.

- ❖ Constructing enclosed berms or backstops at outdoor firing ranges.

- ❖ Procuring and installing bullet traps which prevent bullets from breaking apart on impact.

- Storing lead-acid batteries in containment facilities or buildings to prevent exposure to and damage by the elements, particularly freezing weather, which can crack battery cases.

Reduce the amount of lead used and reduce lead exposure by:

- Identifying ways to remove lead from body surfaces, clothing, and equipment exposed to lead during training and readiness activities, should research indicate this is a problem. These methods could include using inexpensive tests to detect the presence of lead, providing the soldiers facilities or supplies (such as hand washing facilities, showers, or cleaning wipes in sealed envelopes) to remove lead from the body, and requiring laundering of field clothing (Hunter, 1994; Martinez, 1993).

- Making changes in training methods to reduce the amount of ammunition expended and miles traveled by military vehicles.

- Reducing the need to repair lead-acid battery posts by improving maintenance procedures.

- Using outdoor firing ranges rather than indoor firing ranges whenever possible.

- Considering eliminating processes such as radiator and battery repair, vehicle painting, and metal sanding under field maintenance conditions.

Substitute other materials for lead by:

- Instituting the use of plastic bullets in indoor firing ranges.

- Using lead-free paint on military equipment when possible.

- Using lead-free solder to repair military equipment when possible.

Eliminate processes which use lead by:

- Using simulators (such as the Weaponeer) for marksmanship training.

- Using lead-free training ammunition when possible.

Risk-Reduction Strategy for Ammunition - DA Actions

The prevalence of lead in military ammunition, however, necessitates detailed discussion of a risk-reduction strategy specific to ammunition. Reducing lead hazards from ammunition can significantly reduce mission-wide lead-exposure risks, but this will have to be a DA-level action. Installations are limited in what they can do.

Reducing Lead Hazards from Ammunition

Existing policy recognizes the need to reduce lead exposure during weapons training. DA has a policy establishing procedures for indoor firing ranges (HQDA Letter, 26 March 1993). Essentially, DA policy is to limit exposure by designing indoor firing ranges with appropriate equipment to ventilate and collect airborne lead. Indoor firing ranges must be inspected by safety, facility engineering, and medical department personnel according to time schedules established in the policy letter. The policy imposes record keeping requirements for installations and MACOMs.

High quality, reliable ammunition is essential for maintaining readiness and success in combat operations. Lead is inexpensive, has excellent ballistic characteristics, and can be recycled. However, lead in ammunition is a significant problem, presenting health and environmental problems during manufacture, storage, use, recovery, and disposal. Further, ammunition contains other hazardous materials besides lead; these substances present problems beyond the scope of this guide. Given the problems associated with lead, and the value of lead for ammunition, conflicts are certain to occur.

The Army leadership will need to make a strategic decision about small arms ammunition, the largest use of lead in ammunition. It appears that some increase in the current R&D effort may be required to accelerate existing efforts to find suitable, cost-effective, less hazardous substances for lead in ammunition which meets military requirements. However, failure to do so may create continued, long-term, cumulative health problems for soldiers and civilian employees, particularly among adult s with long-term occupational lead exposure.

A reassessment of small arms ammunition may be appropriate not only for health and environmental reasons but for operational reasons as well. Redesigning ammunition to eliminate toxic materials could be combined with an effort to improve performance characteristics of ammunition.

Reducing the Amount of Ammunition Expended

Reducing the amount of ammunition expended would reduce the possibility of lead exposure. The Army already uses training devices which simulate firing rifles; these devices could be used more extensively and fielded more widely. The cost of procuring additional simulators could be offset by the savings in ammunition expenditures and savings in remediation cost for ranges contaminated by lead.

Reducing the Amount of Lead Released from Ammunition

To reduce the amount of lead released from ammunition, the Army could:

- Procure fully jacketed bullets for smaller caliber weapons. This change could prevent lead from being removed from the base of the bullet by expanding gases when the weapon is fired; it will not prevent releases of lead when the projectile breaks apart upon impact (Frigiola, 1994).
- Develop primers for small arms ammunition which contain less lead.
- Accelerate and expand R&D efforts to evaluate new, innovative indoor and outdoor range backstops which maintain the integrity of the projectile upon impact (Van Dervort, 1994).
- Develop fully jacketed projectiles which do not break apart upon impact.

Eliminating Lead .from Ammunition

To eliminate lead from ammunition, the Army could:

- Develop lead-free primers.
- Develop substitutes for lead or lead components in bullets and other projectiles.
- Develop lead-free fuses and detonators.

Developing Lead-Free Training Ammunition

Ammunition intended for marksmanship or live-fire training use must meet the same operational and storage requirements for ammunition used in combat operations; however, some substitutions may be possible. Considering that the ballistic characteristics, as well as its ability to properly cycle or operate the weapon, must be the same, the Army could:

- Consider procuring commercially available small arms ammunition made from metals other than lead and containing lead-free primers.

- Consider eliminating lead-containing primers in blank ammunition (but not ball ammunition), which may not need to meet the same storage and shelf-life standards as ammunition intended for combat use or live-fire training.

- Consider procuring small arms ammunition which contains lead-free primers and lead-free projectiles for use in live-fire training on fixed, known distance ranges and reserving lead-containing ammunition for operational use.

- Integrate and accelerate current Army and private industry R&D efforts directed toward the reduction or elimination of lead and other toxic materials in ammunition (Vogelsang, 1994; Frigiola, 1994).

Expanding Efforts to Limit Hazard .for Those Using Ammunition

To help protect the health of those using ammunition, the Army should consider:

- Expanding Army ammunition development and health protection efforts to include other nations, particularly North Atlantic Treaty Association and other alliance members. Including these partners would be advantageous from an R&D perspective and necessary for alliance purposes. Ammunition should be viewed as an alliance problem. not solely as a national problem.

- Expanding and refining USACHPPM's (formerly USAEHA's) Army-wide lead-exposure, statistical-collection program to include training and readiness as distinct categories with precise definitions of the various activities involved in training and readiness.

- Requiring soldiers firing weapons to wash exposed body surfaces and clothing as soon as possible after firing weapons.

- Considering using plants to remediate soils in training areas which have become contaminated by lead. This would require some R&D, and may have applications for remediation of soil in residential and industrial areas as well (Henson, 1994).

Current Army Initiatives to Control Lead Hazards During Training

Recognizing that lead in ammunition presents a potential problem for the environment, the Army Environmental Center (AEC), in conjunction with the ATSC, has initiated an effort to formulate a strategy to prevent the migration of heavy metals from small arms ranges. The strategy has six components:

- A risk assessment model to ascertain the potential for contamination at specific sites;
- Site criteria for new ranges;
- Evaluation of new berms for both mitigation potential and erosion control;
- Development of a range manual for site remediation and recycling;
- Evaluation of substitutes for lead in ammunition; and
- Evaluation of site remediation methods.

This project is being managed by the Combat Training Support Directorate of the ATSC, which is a field operating agency of the Deputy Chief of Staff for Operations and Plans. The objective of the project is to look at outdoor firing ranges not indoor firing ranges. Not all the projects have been funded (Van Dervort, 1994). The objective of this strategy appears to be the prevention of potential environmental problems. However, it could help to reduce lead exposure, particularly if it results in reducing or eliminating lead in ammunition. This effort should be integrated with Army occupational health programs to achieve maximum program integration.

Lead Used During Training and Readiness

The majority of lead used in training and readiness is in ammunition. Lead in ammunition presents the most severe risks to human health when used in indoor firing ranges; this hazard is well known and is monitored by the Army industrial hygiene community. Outdoor firing presents risks from the lead used in ammunition primers; however, the most significant

economic problem with outdoor firing ranges appears to be environmental. Lead deposited in ranges from weapons firing may cause violations of laws such as the Clean Water Act or the RCRA.

Estimating economic factors associated with lead in ammunition is difficult for several reasons:

- Ammunition, range development, and remediation are in a state of flux. It is not clear what ammunition/range/remediation configuration will emerge as the Army standard.
- The type of ammunition used (e.g., lead bullet, jacketed bullet with lead base exposed, fully jacketed bullet, lead-free bullet, tungsten alloy bullet, plastic training bullet, or frangible bullet) will influence the amount and type of lead deposition and the type of controls and remediation needed.
- Lead deposition in ranges is variable, depending on the age of the range, intensity of use, type of ammunition expended, geological and hydrological conditions, and the presence of other toxic materials.
- Lead-remediation technologies vary in method, cost, and effectiveness.
- New types of bullet traps for indoor and outdoor firing ranges have the potential to reduce or possibly eliminate environmental contamination problems.

Indoor Firing Ranges

Indoor firing ranges present significant health risks, especially for range staff assigned responsibility for operating the range. Because of these risks and risks to those using the range on an intermittent basis, indoor firing ranges are typically equipped with ventilation systems and high efficiency particulate air (HEPA) filtration systems. Periodic cleaning is required to meet health and safety requirements.

The cost to clean one indoor range, at Fort Belvoir, Virginia, was $15,303; this cost included changing the HEPA filter on the ventilation system. The range has ten lanes and is used for pistols and rifles using subcaliber ammunition. According to Fort Belvoir personnel, the range should be cleaned annually, although this may not be supported by existing funding levels (Findlay, 1994).

One private contractor estimated that the cost to clean a typical five-position indoor range, which includes removing lead from the bullet trap and vacuuming using HEPA

equipment, ranges from $1000 to $4000 per range depending on local conditions. More extensive cleaning, such as wet cleaning of range surfaces, could increase the cost by a factor of four (Hayes, 1994).

If ranges were cleaned by range staff, costs could be reduced, although some costs would be accrued for worker protection, cleaning equipment, materials, and disposal of wastes. A single cost estimate for this type of cleaning is not available because of the variable nature of ranges and variations in cleaning procedures.

Outdoor Firing Ranges

Outdoor firing ranges present environmental problems because of lead contamination of the environment. The cost of lead is reflected in remediation costs. It is important to note that continued use of lead at a range will most likely require additional remediation until lead deposition is eliminated.

A price quotation obtained from a private company specializing in the remediation of toxicities in soil showed that soil at exterior ranges contaminated with lead from bullets could be decontaminated for $70.00 per cubic yard. This would involve screening to remove larger pieces of lead, followed by treatment to stabilize any residual lead to reduce its mobilization and potential transport within the environment and to meet State regulatory requirements. The recovered lead can be sold to lead recyclers (McLaughlin, 1994).

The Salt Lake Research Center of the Bureau of Mines, under contract to the Navy, has conducted remediation projects at Camp Pendleton, California and Quantico, Virginia to remove lead from soil at firing ranges. Data analysis is still underway, and the Quantico project is still in progress. Initial estimates indicate that remediation costs will vary on a sliding scale between $50 and $100 per ton, depending on the type of soil; sandy loams are less expensive to remediate than clay, which predominates at Quantico. Additional data analysis may result in changes in the cost estimates (Lym, 1994).

Given the cost of $70.00 per cubic yard, a rough estimate of the cost of remediating all Army ranges can be determined. The Army operates approximately 2,100 ranges (Ervin, 1994). If the number of cubic yards of earth, in the form of berms and flat range areas were known, an initial cost estimate could be determined.

An estimate obtained from an Army source for the cleanup cost for lead contaminated outdoor firing ranges placed the cost at $500,000 per range (Vogelsang, 1994). This was considered to be a conservative estimate.

Given the problems with lead contamination, installations have initiated efforts to implement solutions to these problems. Fort Drum, in New York, is considering the installation of bullet traps to prevent lead hazards. A private firm is installing a bullet trap at the Quantico Marine Corps Base intended to capture bullets intact to prevent lead contamination and to facilitate recovery and recycling of the bullets. Marine Corp representatives indicate that the trap has performed satisfactorily and may be installed Marine Corp wide. Cost data on the trap are not presently available (Rogers, 1994; Fletcher, 1994).

To target resources in reducing lead hazards from ammunition, the Army should consider these actions as immediate steps:

- Eliminating hazards from indoor firing ranges, because of both health hazards as reported in the HHIM and cleanup cost, as a first priority.
- Installing bullet traps which capture whole bullets at all indoor firing ranges. This will allow recovery of lead-containing bullets, thus lowering cleaning and remediation cost, as well as the recovery of bullets made of more valuable materials, should the Army transition to other materials, such as tungsten for bullets.
- Developing a cost date on remediation of outdoor firing ranges.

Appendix D

Logistical Operations

Sources of Exposure

Identifying and quantifying the sources of lead exposure and contamination for this mission area are more difficult than for other areas. Large industrial facilities within the AMC have generally predictable production rates and relatively clearly defined sources of lead exposures. Army logistical operations, however, tend to vary in intensity, duration, types of material handled, facilities, and working conditions, and are characterized by a higher rate of personnel turnover than in large depots.

However, even given these variables, it is possible to list the most common activities which could possibly result in lead exposure. These include:

- Packaging, shipping, storing, issuing, receiving, and disposing of ammunition, batteries, repair parts, supplies, and materials which contain lead.

- Performing maintenance activities on vehicle parts, such as lead-acid batteries, radiators, and vehicle wheels (lead wheel weights), which contain lead; using metals or alloys containing lead to perform repairs on military equipment such as vehicles, weapons, and communications equipment; performing maintenance activities, such as soldering of electronic equipment (Bellows and Rudolph, 1993); applying, repairing, or removing paints or other coatings containing lead.

- Operating motor vehicles and using MHE.

- Operating vehicle or equipment salvage yards.

- Operating facilities in support of logistical operations.

- Purchasing and contracting for supplies and equipment, while not a source of exposure, represents a significant way in which material containing lead enters military logistical systems.

Packaging, Shipping, Storing, Issuing, Receiving, and Disposing of Materials

Commodities such as ammunition, repair parts, batteries, solder, and lead seals used on tire extinguishers and vehicle firefighting systems are some of the lead-containing materials

which move through Army logistical channels. Typically, these materials are packaged in such a way as to prevent contact as they move through various levels of supply. However, as packages are opened, either for use, for repackaging, or through breakage during shipment or handling, the possibility exists that supply personnel could be exposed to some lead as they handle the material. Although uncommon, fires, floods, or explosions in storage facilities could release lead to air or water, creating a pathway for inhalation, ingestion, or environmental damage.

Disposal of material presents a complex set of possible exposure pathways. Personnel likely to be exposed to lead-containing materials are those directly involved in disposing material. These activities include the operation of waste incinerators, recycling centers, paper shredders, hazardous waste storage facilities, and scrap yards. Exposure pathways and amounts of exposure will vary depending on the method of waste disposal and the amount of lead containing waste being disposed of.

Performing Maintenance Activities

Logistical operations involve a broad spectrum of equipment-maintenance activities of all types, conducted by soldiers with a wide range of MOSS and by civilian employees from numerous crafts and trades. These activities include the maintenance and repair of vehicles, weapons, communications equipment, and electronics.

Lead exposure from these activities occurs in several ways. Solder containing lead used to repair vehicle radiators and various electronic components can be vaporized and inhaled. Personnel who clean battery terminals, and service, charge, or repair lead-acid batteries could also be exposed. In addition, used engine oil may contain lead from bearings or from combustion of leaded gasoline (in areas and applications where leaded gasoline is still used), while used radiator coolant may contain lead from solder. The removal and handling of these used fluids may represent a risk.

Maintenance shops conduct a wide variety of work, such as maintenance on vehicles and heavy equipment. Industrial operations will include cutting, welding, and grinding metal such as steel and brass. If these metals include lead as an alloy, are coated with leaded paint, or otherwise contain lead, the personnel performing this operation may be exposed. If the airborne lead is not contained, auxiliary personnel, such as painters, mechanics, and fork lift operators, may be exposed as well.

Although the use of lead-containing paint is prohibited for use in residential facilities, its use is permitted on military equipment. General Services Administration (GSA) representatives identified six specifications which actually require lead in certain colors or as a basic ingredient; another fifty contain no prohibition on lead and may or may not contain lead (Finch, 1995). An

October 1993 Air Force review of approximately 2800 GSA paint and coatings national stock numbers (NSNs) determined that 10 NSNs contain lead, 284 contain lead in certain colors, and that 11 NSNs contained lead in the pigments (Kaminskas, 1995). The use of these paints on military equipment creates the potential for exposure for as long as the equipment is in the Army (or other organization) inventory. When the paint is removed or the underlying metal is worked, the potential for exposure is created. AR 200-1 is currently under revision. The most current draft contains a prohibition on the use or acquisition of lead-containing paint; this is likely to lead to the eventual elimination of the use of lead-containing paint on equipment. After the prohibition goes into effect and the use of LBP on equipment IS eliminated, only lead-containing paint on equipment painted before the ban will present a potential source of exposure.

Cleaning and repairing weapons contaminated with lead residue from primers or projectiles presents another exposure pathway, primarily by ingestion of lead deposited on the hands or mucous membranes, although lead particles could be inhaled during the manual cleaning process. Any painting, paint removal, or spot painting of equipment using lead-containing paint may result in exposure as well. Some exposure could result from working with various types of hardware and machine parts made from various types of brass containing lead. Communications and electronics equipment contain small amounts of lead on printed circuit boards which could volatilize when conducting spot-soldering repair work.

Operating Motor Vehicles and Using MHE

Typically, fuel from motor vehicle operations is not a significant source of lead since leaded fuel has been phased out in the United States. However, leaded fuel is still in use in some nations where United States forces are stationed or deployed; if locally procured fuels are used, some exposure should be anticipated. Other potential sources of lead contact include: while attaching or detaching jumper cables for "jump starting" vehicles, while changing tires with lead wheel weights (used to balance tires), lead-containing solder on vehicle light bulbs and radiators, and lead components of brake systems. While relatively infrequent, these are possible exposure pathways common to almost all military vehicle operators.

Operating or maintaining fork lifts which use lead-acid batteries may also result in exposure, primarily during battery charging or during battery maintenance procedures.

Operating Vehicle or Equipment Salvage Yards

Units or installations may operate salvage yards where vehicles which have been damaged beyond repair or destroyed are stripped of parts or "cannibalized." Lead exposure could result from handling lead-containing materials or from using cutting torches which could

melt or burn leaded paints and lead-containing metals. If lead-acid batteries are stored on the site, some exposure could result from broken batteries.

Operating Facilities in Support of Logistical Operations

Logistical operations are conducted in many types of facilities, including warehouses; fuel storage and distribution facilities; vehicle maintenance facilities; various shops; and in a variety of tents, shelters, vehicles, and vans. Leaded paint is likely to be present; some facilities may contain lead from decades of contamination by leaded fuel, battery maintenance operations, and spray painting. Some facilities may be rented, temporary, or located in other nations. Pathways could include inhalation and ingestion; the extent to which this is a problem is unknown.

Purchasing and Contracting

Purchasing and contracting activities do not expose personnel to lead; however, because the Army logistical system includes very large, decentralized, and effective systems for purchasing and contracting goods and services of all types, it should be considered as a factor in an overall lead strategy. When purchasing supplies and equipment or when contracting for services, the needs of the ultimate user or consumer take priority. Although much acquisition of material is accomplished by national-level supply systems, much is done locally at installations by thousands of contracting officers. If they are unaware of the possible problems caused by lead or unaware that the materials contain lead, they may enable procurement of materials containing lead when lead-free materials are adequate. Traditionally, lead-containing materials with currently available lead-free substitutes include paper containing lead in inks, solder containing lead, and exterior paints containing lead. Suitable substitutes appear to be available for all these uses.

Risk Assessment

Lead hazard risk assessments associated with logistical activities present a challenge. In some cases, the uses and hazards are identified and well known. Battery maintenance and soldering are activities where exposure is possible and for which various hazard-reduction

strategies have been designed. The data in Table D-1 shows the number of Army employees the HFTTM identified as potentially exposed to lead hazards during activities classified as logistical for the purposes of this guide:

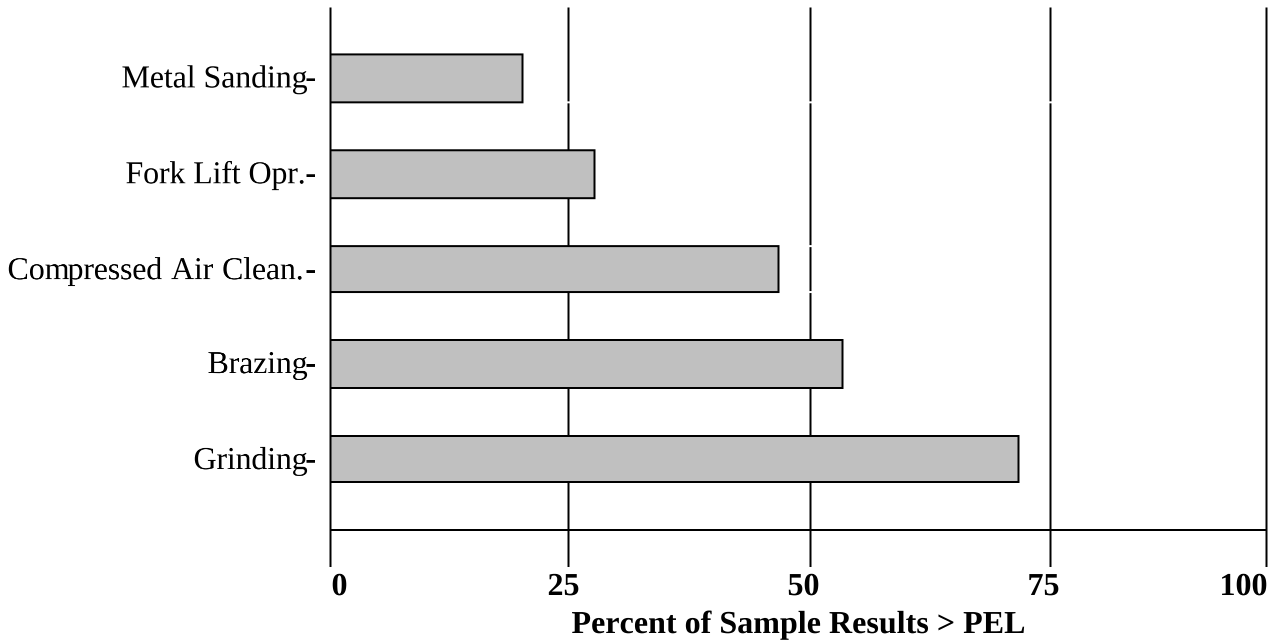
Table D-1. Exposure to Lead During Logistical Activities

	# Exposed	Males	Females	Military	Civilian	Contractor
RAC 1	42	38	4	8	34	0
RAC 2	191	180	11	28	163	0
RAC 3	3,304	3,033	271	2,011	1,293	0

Figure D-1 illustrates that logistic activities can result in lead exposure. These activities generate airborne-lead levels well above the OSHA PEL. These sample results would be considered a violation of Federal law depending on the engineering controls and PPE used. A review of HHJM information regarding the PPE and engineering controls used while these airborne samples were collected suggests that workers were not adequately protected from lead exposure in some instances. Information regarding specific operations performed without adequate controls is detailed in Appendix H.

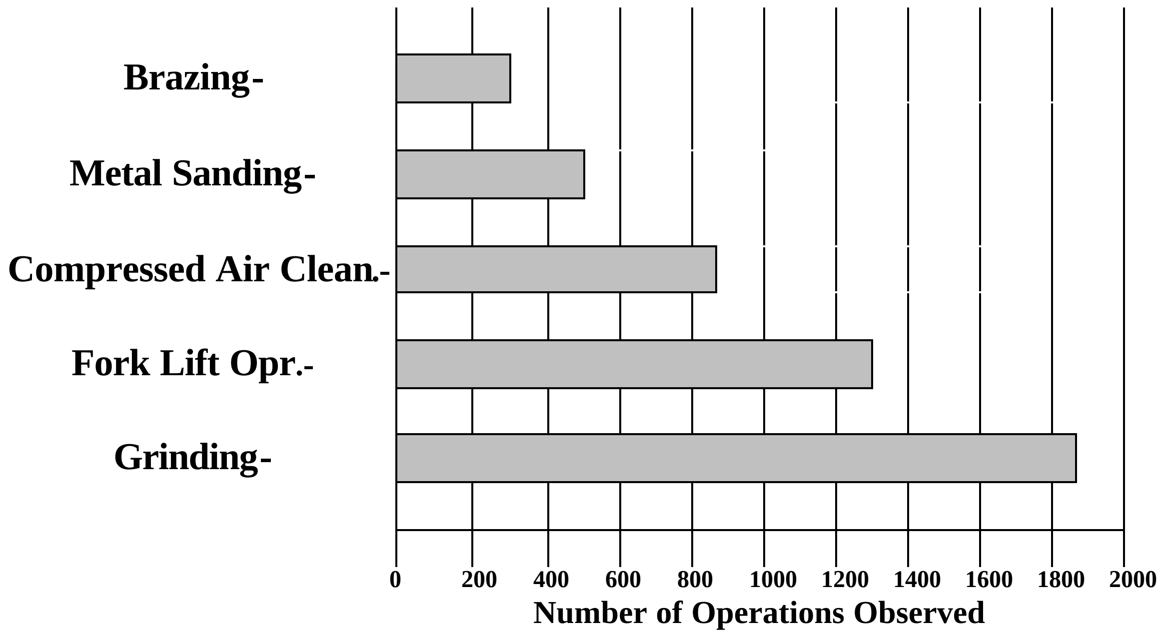
The activities selected for presentation in the graph rated with RACs of 1 (Critical) or 2 (Serious) are only a small portion of the logistical operations associated with lead. Other activities that can result in exposure include soldering, sandblasting, painting, and compressed air cleaning. The HHIM data represent only those operations that have been surveyed and reported to this; this is a subset of Army logistical operations.

Figure D-1. Logistics
Percent of HHIM RAC 1 and RAC 2 Lead Air Sample Results
Exceeding the OSHA PEL



Although a precise estimate of the frequency of lead-associated operations occurring is not available, Figure D-2 provides a conservatively low estimate of how often an operation occurs Army wide.

Figure D-2. Number of RAC 1 and RAC 2 Operations Observed or Surveyed Army Wide During 1994



The data provided by HHIM represent surveys or observations by Army industrial hygiene staff conducted in 1994. Although lead-air monitoring was not performed during each survey, the industrial hygienist specifically noted that the operation was taking place during a walk-through or more extensive survey. It is likely that the number of occurrences is higher than the frequency suggested in the graph.

No numerical weighting can be performed by combining the information presented in the previous and following graphs, due to differing time periods (one year of data vs. multiple years) and the variation of control and cleanliness associated with the performance of the same task at different installations.

The five activities shown in Figure D-1, however, may or may not represent those activities in the Army with the highest lead hazard for a widespread number of personnel because of the following database limitations:

- ❖ Both the monitoring and the number of personnel performing the activities are based on limited data. For example, monitoring data for only six fork lift operators were available in the HHIM. Similarly, only the number of fork lift operators noted by the industrial hygienist at the specific location was recorded; these findings were not extrapolated to Army-wide operations.

- ❖ The monitoring data may not be representative of all Army activities. For example, monitoring may have been conducted in areas with a known lead hazard, whereas all of the activities shown in Figures D-1 and D-2 are performed using both lead and lead-free materials.

- ❖ Not all activities identified in Appendix D may be in the HHIM.

Risk-Reduction Strategy

Installations have a range of options available to them to protect human health from lead hazards. Some installations have already implemented some of these practices as part of larger pollution prevention or safety programs. Installations could:

Avoid lead hazards by:

- ❖ Educating installation logistical personnel and logistical unit staffs on ways to avoid contact with lead-containing materials.

- ❖ Placing warning labels that contain safe handling instructions on the packaging of materials containing lead.

- ❖ Providing PPE to those required to handle lead-containing or lead-contaminated materials.

Contain lead hazards by:

- ❖ Improving packaging of lead-containing materials. This could include issuing solder and wheel weights in plastic bags and packaging lead-acid batteries to prevent contact with battery terminals.
- ❖ Practicing stricter inventory control of lead-containing materials.
- ❖ Requiring the return and safe disposal of lead-containing materials, including used vehicle wheel weights, batteries, hardware, ammunition residue, radiator parts and old solder, and spools and containers.
- ❖ Instituting better methods to package, handle, secure, and safely store used lead-acid batteries.
- ❖ Prohibiting the incineration of lead-containing material in installation waste incinerators.
- ❖ Maintaining paint in logistical facilities in good condition.
- ❖ Procuring and using shrouded power tools with HEPA filtered dust-recovery systems.

Reduce lead hazards by:

- ❖ Reviewing maintenance procedures to ensure the minimum necessary amounts of lead-containing materials are used.
- ❖ Consolidating lead using activities (such as metal sanding, soldering, brazing, and welding) into centralized facilities with appropriate protective and safety equipment and environmental controls.
- ❖ Consolidating direct support level battery maintenance at installation or general support level (Galluzzo, 1994).
- ❖ Providing additional detection and decontamination materials for those working with lead-containing materials.
- ❖ Reviewing procedures for fork lift battery maintenance and charging operations to reduce lead exposure.

- ❖ Ensuring that the installation safety, medical, environmental, and industrial hygiene personnel work as a team to locate, test, monitor, and reduce health hazards related to lead, particularly in military logistical units.

- ❖ Including lead as a priority substance in installation pollution-prevention programs.

- ❖ Removing materials suspected of containing lead, including paint and solder, prior to conducting "hot" repair work such as welding or brazing. Such activities could volatilize lead that may be present in the material.

<u>Substitute other materials for lead by</u>:

- ❖ Procuring lead-free solders as they become commercially available.

- ❖ Procuring lead-free paint and lead-free paper inks. Lead-free paints for vehicle repair, steel equipment, and other repainting applications are widely available. Similarly, lead-free inks are also readily available.

- ❖ Specifying, in contracts and local purchases of supplies and equipment, that the materials be lead free if lead-free materials will meet user requirements.

- ❖ Planning for stocks of lead-free fuel in OCONUS locations.

- ❖ Using lead-free paint on logistical facilities.

<u>Eliminating processes such as</u>:

- ❖ Sandblasting or other abrasive paint removal techniques when practical.

    Alternative paint removal techniques include vacuum blasting, wet abrasive blasting, and chemical stripping. (Vendors of these technologies are listed in the annual <u>Journal of Protective Coatings and Linings</u> buyer's guide.) "Overcoating" can be performed if only minor maintenance is necessary. In this technique, hand or power tools can be used to remove deteriorated paint while retaining the intact paint. A recent detailed review of overcoating, including a products directory, is found in the <u>Journal of Protective Coatings and Linings</u>, November 1993. These techniques result in lower levels of airborne lead in the workplace, although tradeoffs may include increased work time and differing surface "cleanliness," which could affect long-term performance of the paint.

- Compressed air cleaning of parts or equipment, if EBP or lead-containing material is part of the equipment.
- Spray painting when brush painting is suitable.
- The use of leaded paint on logistical facilities and equipment, such as fuel pumps, tanks, and motor pools.
- Unprotected outdoor storage of lead-acid batteries.

Lead-Acid Batteries

Costs associated with lead-acid batteries tend to be low because of the way lead is used in batteries. Lead is almost fully contained in the battery, and recycling systems exist for lead-acid batteries. There appears to be little exposure during normal battery operations, with the exception of soldiers and civilian employees cleaning battery posts while performing operator maintenance or during handling when batteries are being recycled.

The single largest cost which seems to be associated with lead-acid batteries is the cost incurred to protect human health when maintenance personnel are required to conduct battery-post repair operations involving the melting of lead to repair the post (TM 9-6140-200-14, 1989). According to the HHIM database, three out of four air samples collected during battery- post repair operations exceeded the OSHA PEL. It is difficult to extrapolate from this limited number of samples, but it does appear that there is a need for more sampling in this area and possibly an analysis of the effectiveness of existing engineering controls.

Another potential exposure can occur if maintenance personnel are required to handle lead-acid batteries which have broken open because of improper storage or handling. Broken batteries present both environmental and health problems.

Given the potential health problems associated with battery-post repair, it seems reasonable to investigate the cost or repair as opposed to the cost of replacing of batteries According to the October 1994, Army Master Data File, the figures shown in Table D-2 are the costs of the most commonly used military batteries.

Table D-2. Costs of Commonly Used Military Lead-Acid Batteries

Model	Cost	NSN	Application
8D 12 Volt	$106.66	6140-00-190-9828	Heavy Engineer Equipment
2HN 12 Volt	$50.26	6140-00-057-2553	Small generators
4HN 24 Volt	$74.53	6140-00-059-3528	Generators
6TL 12 Volt	$60.60	6140-01-210-1964	Vehicles; many applications
31T 12 Volt	$58.62	6140-01-037-6882	Commercial Vehicles

The costs of battery-post repair include: the cost of raw lead; equipment used to melt, pour, and form the new battery post; OSHA-required PPE; engineering controls; equipment maintenance; labor costs; medical examinations for occupationally exposed workers; and industrial hygiene support costs.

Information obtained from an Army battery shop supervisor at Fort Belvoir, Virginia indicates that battery-post repair is performed by a Wage Grade 6 employee, and the average repair time is one hour at a combined hourly wage and administrative overhead rate of $28.50 per hour. This is considered to be a conservative estimate and does not include the cost of other staff support.

Battery-post damage is relatively infrequent and typically results from one of two causes: loose battery clamps resulting in increased electrical resistance, arcing, and sparking which melts the post, or improper connection of jumper cables which melts the post. Both causes are results of improper maintenance procedures and could be prevented by improving maintenance training and maintenance procedures. Most batteries turned in for post repair are used and have a reduced service life. Some batteries may have the post repaired but still may not be serviceable when charged and tested.

Given the cost of the most commonly used military battery (6TL 12 Volt), at $60.60 per battery, it does not seem economically feasible to repair it for $28.50, given the typically reduced service life, the health risks, and the possibility that the repair may not be effective.

Shipping damaged batteries to Army depots with well-designed repair facilities does not seem economically feasible because of transportation cost.

An economic analysis performed at Fort Belvoir resulted in restricting installation level battery maintenance to filling and charging. Batteries with damaged posts are turned into the local Defense Reutilization and Marketing Office (DRMO) as unserviceable (Riley, 1994).

To target resources to eliminate these hazards, the Army should consider:

- Eliminating battery-post repair as an Army maintenance procedure.
- Forming a partnership with the Advanced Lead-Acid Battery Consortium for the specific purpose of designing a battery which does not require post repair.
- Expanding vehicle-operator training to include emphasis on proper maintenance procedures and jump-starting procedures.
- Designing future vehicles with built-in slave cable connectors to eliminate improper jump-starting procedures.
- Improving battery-storage procedures to prevent the batteries from freezing, splitting, or breaking.

Several advantages would accrue to the Army by adopting this strategy. First, it would eliminate a source of lead hazard to workers. This would eliminate the need for OSHA-required controls and other costs associated with battery-post repair. Second, it would eliminate the potential for OSHA violations. Third, it could help reduce environmental problems resulting from broken batteries. Finally, eliminating this procedure could help the Army reduce airborne emissions of lead, thus helping the Army meet the requirements of EO 12856 which requires a reduction in toxic releases to the environment by Federal agencies.

If pending legislation permits regulatory agencies to levy fines against Federal facilities, a single fine could eliminate any possible financial savings to the Army from repairing battery posts.

Lead Use in Logistical Operations

Lead is a minor component in a variety of supplies and equipment used in industrial and logistical operations. For example, vehicles may contain lead in the brass fittings used in fuel lines, in lead containing solder in electronic equipment, and in paint used on equipment.

These uses tend to involve relatively small quantities. They may result in limited exposures, such as mechanics replacing fuel lines with lead-containing brass fittings, or in relatively hazardous exposures, such as depot-level paint removal.

Precise or even rough estimates of the costs associated with lead use in industrial and logistical operations are difficult to obtain because of the diverse applications of lead. However, the HHIM database has identified welding, grinding, and abrasive blasting as processes which result in lead exposure. The HHIM data also suggest that, in many cases, PPE and engineering controls are adequate to prevent hazards to human health, although in some cases this does not appear to be so.

The problem of estimating the costs of lead use in miscellaneous applications is recognized by the EPA. Representatives interviewed indicated that there are no firm estimates of the costs of lead use. EPA is considering regulating some miscellaneous uses but not those typically associated with industrial or logistical operations (Jacobson, 1994).

Given this uncertain cost situation, it is difficult to target precise processes or applications for lead substitution or elimination. However, it does appear likely that the Army can reduce the cost of protecting human health by considering these options:

- ❖ Eliminating LBP from use on military equipment whenever possible.
- ❖ Specifying that lead-free solder be used on military equipment, especially when only small amounts of solder are used; the cost does not add substantially to the cost of the equipment, and appropriate manufacturing technology is in place.
- ❖ Forming additional partnerships with industry and research organizations, and expanding existing research to develop lead-free metal alloys and solders for use in military equipment as part of manufacturing technology programs.
- ❖ Analyzing the HHIM data to pinpoint the most hazardous miscellaneous uses of lead in precise industrial and logistical operations.
- ❖ Including industrial and logistical facilities in LBP management programs,

Appendix E

Industrial Operations

Sources of Exposure

Many of the sources of lead exposure in industrial operations are the same as those in logistics. Additional sources of lead result from manufacturing operations, which are not found in logistics. The sources of lead exposure and contamination in industrial operations are relatively well known. These sources and appropriate exposure-reduction strategies are:

- Manufacture of major end items of equipment;
- Equipment modification and maintenance activities;
- Manufacture and demilitarization of ammunition;
- COSIS;
- RDT&E activities; and
- Facility operations.

Manufacture of Major End Items of Equipment

Army facilities manufacture main battle tanks, artillery cannon, and a variety of smaller items. The material and processes used to produce these items (such as welding, grinding, and painting) could result in releases of lead, typically in the manufacture of components, the use of various solders, and incidental releases from small parts containing lead.

Equipment Modification and Maintenance Activities

At times, Army depots have requirements to modify or improve equipment or requirements to overhaul or rebuild equipment. Typically, various depots will operate vehicle rebuild lines, overhauling many vehicles of the same type. These activities often involve complete disassembly and reassembly of items of equipment, restoring it to a like new condition. If lead or lead-containing materials are used in the process, the possibility for exposure exists. These sources are similar to those discussed in Section 4.3.2, including painting, cutting and welding of lead containing metal, and handling of parts containing lead.

Manufacture and Demilitarization of Ammunition

Ammunition manufacturing includes the manufacturing of initiators such as lead azide, other explosives, bullet cores, and the assembly and testing of these materials. Lead is present in the cores of various caliber bullets and in primers for cartridges or explosives. Lead exposure can occur from all phases of the ammunition manufacturing process, including raw material handling; the manufacture of initiators and bullet cores; the downstream assembly of these materials with other lead and nonlead containing component; testing; and the handling of deactivated waste streams such as waste waters, floor sweeps, and other process waste. At times, ammunition which is no longer serviceable or which has passed its expiration date is disassembled and its component parts reused or disposed of. This presents possible additional lead exposure.

COSIS

Army stocks contain vast amounts of supplies and equipment placed in storage to support contingency plans or daily operations. These supplies require maintenance to prevent deterioration. These activities include corrosion prevention; painting; repackaging; cleaning; servicing; testing; stock rotation; and disposal of outdated, excess, expired, or damaged stocks. While probably not a particularly large consumer of lead, COSIS activities have the potential to expose Army personnel to lead mainly from working with leaded paint and from servicing lead-acid batteries.

RDT&E Activities

The development of new weapons systems, or the upgrade of existing systems, will involve extensive RDT&E activities. Some of these activities, particularly weapons development, may involve the use of lead in ammunition. The actual construction of prototypes of equipment may involve the use of lead in paints or in component parts.

Facility Operations

Army industrial operations are housed in a variety of facilities, which are somewhat different from those found at a typical installation. Many were constructed and maintained well before the bans on lead-containing paint and lead-containing plumbing came into effect. It is possible that stocks of leaded paint were used up on industrial facilities after the ban on residential use came into effect. Army industrial facilities are likely to contain more leaded paint than other sets of Army facilities; some may have become contaminated by lead releases from various industrial operations. Maintenance on these facilities represents a potential lead exposure pathway.

Risk Assessment

Assessing the risk to Army personnel from Army industrial activities appears to be easier than for other mission areas, because these operations usually take place in fixed facilities, using known quantities of materials in standardized, repetitive industrial operations (See Appendix D for a more detailed list of specific industrial activities).

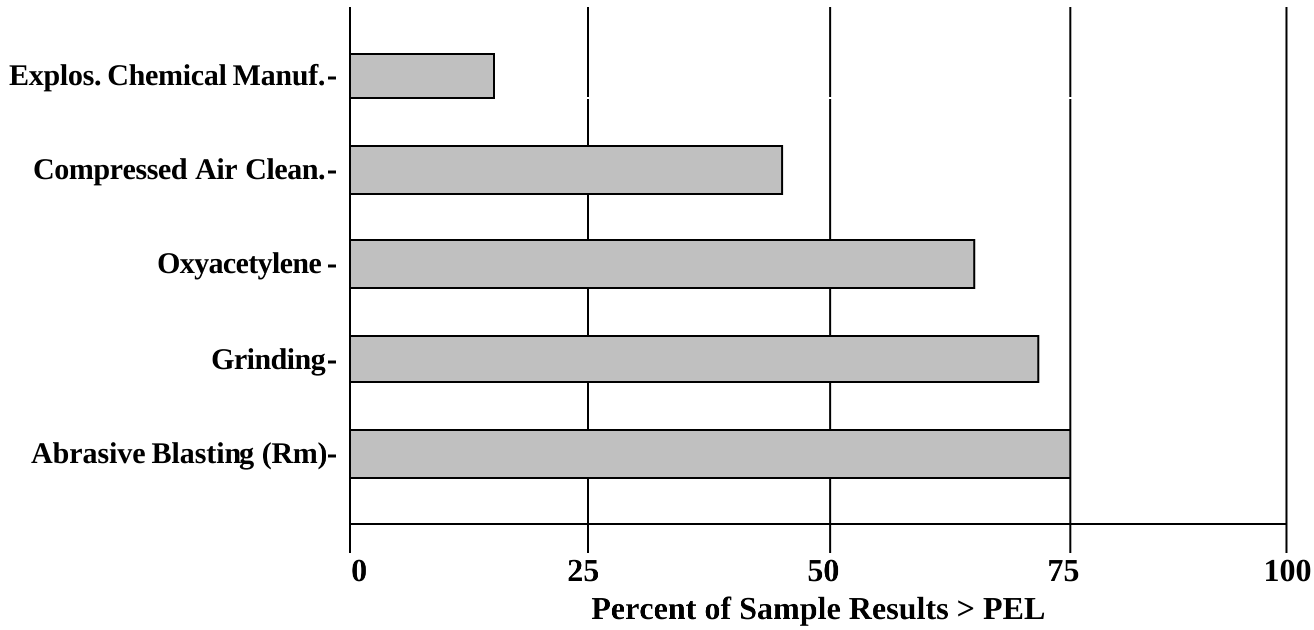
USACHPPM data reveal the number of Army personnel potentially exposed to lead while engaged in industrial operations. One problem with assessing risk in industrial operations is that the data collected contains very little information on government contractors. Since most ammunition plants are GOCO plants, the full extent of health risk may not be apparent. However, since most Army industrial activities take place within AMC, this makes both assessing risk and managing risk somewhat easier. Table E-1 shows the number of exposures by RAC for various categories of adults in the work force.

Table E-1. Exposures to Lead at Industrial Operations

	# Exposed	Males	Females	Military	Civilian	Contractor
RAC 1	194	162	32	0	194	0
RAC 2	505	462	43	38	466	1
RAC 3	4,053	3,737	316	1,945	2,108	0

Figure E-1 illustrates that various industrial operations can result in lead exposure.

Figure E-1. Industrial Operations
Percent of HHIM RAC 1 and RAC 2 Lead Air Sample Results
Exceeding the OSHA PEL

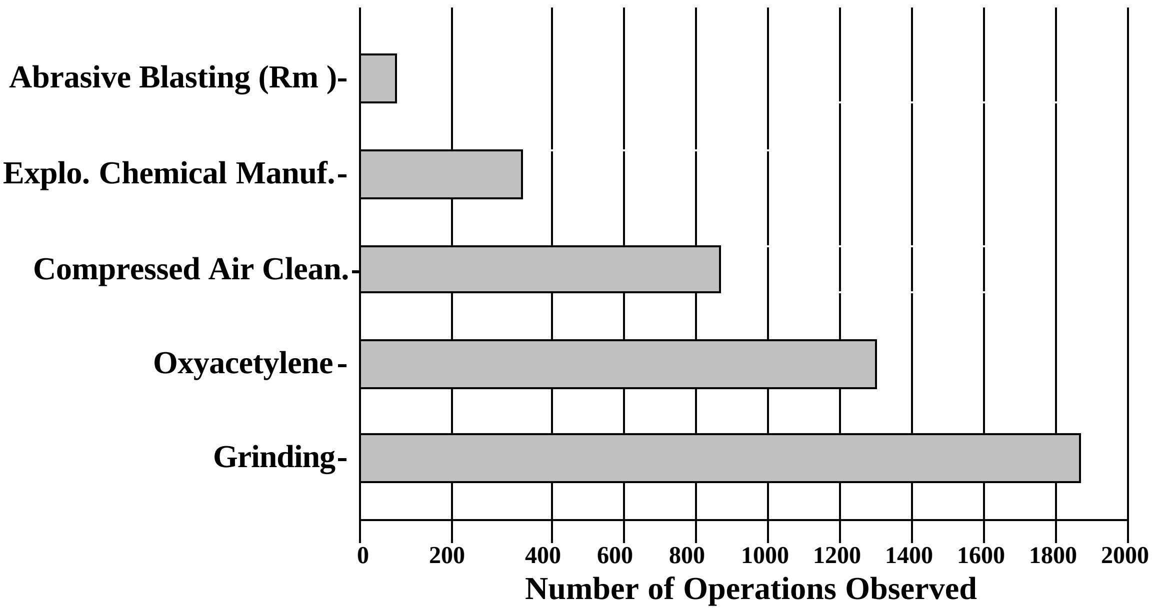


These activities generate airborne-lead levels well above the OSHA PEL. These sample results would be considered a violation of Federal law depending on the engineering controls and PPE used. HHIM information regarding the PPE and engineering controls used while these airborne samples were collected suggests that workers were not adequately protected from lead exposure in some instances. Information regarding specific operations performed without adequate controls is detailed in Appendix H.

The activities selected for presentation in the graph, rated with RACs of 1 (Critical) or 2 (Serious) are only a small portion of the industrial operations activities associated with lead. Other activities that can result in exposure include lead pouring operations, pneumatic tool operation, soldering, and spray painting.

Although a precise estimate of the frequency with which lead-associated operations occur is available, Figure E-1 provides a conservatively low estimate of how often an operation occurs Army wide.

Figure E-2. Number of RAC 1 and RAC 2 Operations Observed or Surveyed Army Wide During 1994



The numerical data provided by HHIM represents surveys or observations by Army industrial hygiene staff conducted in 1994. Although lead-air monitoring was not performed during each survey, the industrial hygienist specifically noted that the operation was taking place during a walk-through or more extensive survey. Thousands of tasks with potential lead exposure take place at Army installations each year. It is likely that the number of occurrences is higher than the frequency suggested in the graph.

No numerical weighting can be performed by combining the information presented in the graphs, due to differing time periods (one year of data vs. multiple years) and the variation of control and cleanliness associated with the performance of the same task at different installations.

The number of facilities conducting the operations in these figures (compressed air cleaning, grinding, abrasive blasting, and oxyacetylene operations such as brazing) is relatively large. Such operations are present at virtually all the equipment manufacturing or maintenance facilities described in Section 4.3.1.

Risk-Reduction Strategy

Significant risks have been observed at the relatively small number of explosives' manufacturing facilities as well as the relatively large number of equipment manufacturing and maintenance facilities. Steps taken to decrease risks in these areas can naturally lead to risk-reduction in other areas. For example, some risk-reduction practices applied to explosives manufacturing can be applied to ammunition manufacturing and vice versa. Similarly, some risk-reduction practices for oxyacetylene operation can easily be applied to soldering or welding.

Reducing the risks posed by lead in the industrial base will depend upon several factors. These include eliminating lead use, better engineering controls to contain lead emissions from existing process, and enhanced worker protection. Industrial facilities could:

Avoid lead hazards by:

- Repairing rather than replacing leaded paint on equipment.
- Requesting that suppliers provide, to the greatest extent possible, lead-free materials.
- Identifying all uses of lead in industrial operations, informing those working with the material about possible hazards, and ensuring all potentially affected personnel are aware of the hazards and use appropriate PPE.
- Expanding and accelerating pollution-prevention efforts.

Contain lead hazards by:

- Reviewing industrial processes to determine ways to improve existing process controls when lead is involved as a raw material or as a component of a base metal. Increased process efficiency will decrease the frequency or volume of lead-containing solid waste, wastewater, and fugitive vapor.
- Procuring shrouded power tools with HEPA-filtered vacuum systems to contain lead dust.
- Using plants which uptake lead (and other toxic material) as plantings around industrial facilities.

- Collecting all lead-containing materials and waste for metals recycling or proper disposal.

- Conducting all painting operations, when using leaded paint, in a paint room (with proper ventilation, personal protection, and overspray collection equipment) to minimize exposure to other personnel.

- Consolidating lead-using activities (such as soldering and welding of lead-containing material) into centralized facilities with appropriate protective and safety equipment and environmental controls. This will also minimize exposure for personnel conducting unrelated activities.

Reduce lead hazards by:

- Investigating ways to reduce the lead content of metal alloys, solders, paints, and parts, including contacting vendors to determine the availability of such materials.

- Investigating the possibility of avoiding the need to perform work on lead-containing parts or equipment components.

- Removing leaded paint from equipment prior to welding, grinding, or sanding.

- Segregating lead-containing waste waters for pretreatment to remove or recover the lead.

- Conducting munitions' or explosives' assembly operations that potentially generate lead dust or fume in remote areas. When entry is required for cleaning or raw material handling, the duration of exposure should be minimized.

- Initiating R&D activities to improve both PPE and environmental controls of lead.

Substitute other material for lead:

- Using lead-free solders and metal alloys wherever possible.

- Using lead-free paints, particularly when no performance advantage is achieved by using LBP.

- Procuring hardware and fasteners which are lead free.

- Using lead-free paint on exterior structures.

Eliminate processes such as:

- Aerosol-can painting using LBP.
- Uncontrolled compressed air cleaning of materials contaminated with lead particles. Control can be achieved by conducting this activity in a centralized area of the industrial operation.
- Noncontained abrasive stripping of LBP, even small areas. Alternative techniques such as vacuum abrasive stripping or chemical stripping will reduce exposure to personnel.
- Grinding of materials coated with LBP.

Lead Use in Industrial Operations

Lead is a minor component in a variety of supplies and equipment used in industrial operations. For example, vehicles may contain lead in the brass fittings used in fuel lines, in lead-containing solder in electronic equipment, and in paint used on equipment.

These uses tend to involve relatively small quantities. These uses may result in limited exposures, such as mechanics replacing fuel lines with lead-containing brass fittings, or in relatively hazardous exposures, such as depot-level paint removal.

Precise or even rough estimates of the costs associated with lead use in industrial and logistical operations are difficult to obtain because of the diverse of applications of lead. However, the HHIM database has identified welding, grinding, and abrasive blasting as processes resulting in lead exposure. The HHIM data also suggest that in many cases, PPE and engineering controls are adequate to prevent hazards to human health, although in some cases this does not appear to be so.

The problem of estimating the costs of lead use in miscellaneous applications is recognized by the EPA. Representatives interviewed indicated that there are no firm estimates of the costs of lead use. EPA is considering regulating some miscellaneous uses but not those typically associated with industrial or logistical operations (Jacobson, 1994).

Given this uncertain cost situation, it is difficult to target precise processes or applications for lead substitution or elimination. However, it does appear likely that the Army can reduce the cost of protecting human health by considering these options:

- Eliminating LBP from use on military equipment whenever possible.
- Specifying that lead-free solder be used on military equipment, especially when only small amounts of solder are used, and the cost does not add substantially to the cost of the equipment.
- Forming partnerships with industry and research organizations, or expanding existing research, to develop lead-free metal alloys and solders for use in military equipment as part of manufacturing technology programs.
- Analyzing the HHIM data to pinpoint the most hazardous miscellaneous uses of lead in precise industrial and logistical operations.
- Including industrial and logistical facilities in LBP management programs.

Appendix F

Base Operations

Sources of Exposure

Activities within the base operations mission area which may result in lead-exposure to Army military and civilian personnel and their families include:

- Facilities' operations and maintenance;
- Construction and revitalization of infrastructure;
- Family-housing maintenance and renovation;
- MWR activities;
- Utilities and services, including waste management;
- Demolition of facilities and infrastructure; and
- Removal of lead-contaminated soils.

All these activities entail some risk of lead exposure. Specific pathways are discussed in the following paragraphs.

Facilities Operations and Maintenance

The Army is responsible for maintaining more than 199,212 buildings and facilities on 12.4 million acres worldwide (EHSC, 1989). Maintenance operations including spray painting, cleaning and sweeping, spray cleaning, repair and maintenance of plumbing fixtures, brazing operations, sanding, and abrasive blasting can involve lead exposure. Lead is often present in street and household dust which becomes airborne and may be inhaled during activities such as street sweeping and cleaning.

The installation DPW, formerly the Directorate of Engineering and Housing, is the primary agency responsible for facilities' operations and maintenance activities. The DPW is comprised mostly of civilian employees or contractor personnel; therefore, civilian DPW employees and DPW contractors are the population at most risk of lead exposure from operations and maintenance activities.

The 1993 HHIM database lists a total of 1,821 persons at 71 facilities who were exposed to lead while conducting facilities' operations and maintenance activities. The HHIM database distinguished four types of operations: maintenance, cleaning/sweeping, spray painting, and multiple operations. Of the 1,821 persons exposed to lead, 1,065 were from maintenance, 647 were from multiple operations, 92 were from cleaning/sweeping, and 17 were from spray painting (AEPI, 1994.)

The 1993 HHIM database includes monitoring results for airborne lead at various installations. The monitoring results were compared to the OSHA PEL of 50 $\mu g/m^3$ for an 8-hour workday. The HHIM database showed 20 elevated airborne-lead measurements for maintenance operations (mean 828 $\mu g/m^3$; range 56-5,500 $\mu g/m^3$), all from Fort Sill, Oklahoma, from August 1991 to November 1991. A similar situation existed with compressed air cleaning at Tooele Ammunition Depot where 11 elevated measurements (mean 66 $\mu g/m^3$; range 47-100 $\mu g/m^3$) were recorded for the period between April 1990 and June 1990.

Workers who install and maintain plumbing at Army bases are included in the 1993 HHIM database as individuals exposed to lead. Thirty facilities reported a total of 388 people exposed to lead from general plumbing operations; 98 percent were military and 86 percent were civilians. Lead exposure occurs from the solder and the pipes, particularly when the plumbing in older buildings and distribution systems is being repaired.

In April of 1994, the EPA released a publication entitled "Reducing Lead Hazards When Remodeling Your Home." The publication explains possible lead hazards from typical maintenance and repair procedures such as sanding, cutting, drilling, sawing, and stripping. It also recommends procedures for worker protection, personal cleanup, and daily- and final-site cleanup. The activities addressed in the database suggest that typical facility maintenance activities may result in lead exposure. It is evidence of continued Federal agency recognition of lead hazards.

Construction and Revitalization of Infrastructure

Even though LBPs were banned for use in residential structures in 1978, structures such as bridges, tanks, tunnels, and water towers were still painted using lead primers (Drozdz, 1993). The lead compounds used as paint pigments include lead acetate, lead borate, lead carbonate, lead chromate, lead silicate, lead sulfate, lead tetroxide, and lead titanate. Paint and varnish dryers also contain lead salts (Lewis, 1993).

Although LBPs and primers are still available and used for industrial, marine, and military application, they are rarely used for Federal- or State-funded highway projects. Zinc or organic-based primers and paints are the principal substitutes.

Most of the steel infrastructure in the nation is coated with LBP (Bass, 1993). For example, nearly all of the 186,000 steel bridges in the United States built before 1980 were protected with LBP (Bass, 1993). The number of bridges presently painted with LBP is less because some of these bridges were since repainted with lead-free paint.

Bridges are sandblasted and repainted routinely to ensure their structural soundness; however, sandblasting of LBP from bridges poses a serious threat to workers inhaling the toxic airborne-paint particles. The many activities conducted by the Army for infrastructure revitalization that involve painting or sandblasting of LBP involve risk of lead exposure.

DPW employees and contractors are the main population at risk of lead exposure from sandblasting and painting of facility structures. Lead compounds which become airborne during sandblasting and painting operations can pose a serious threat to workers inhaling paint particles, and may present a problem to others as “take-home lead” transported off the job site on workers’ clothing or in their vehicles.

A second group potentially at risk from airborne lead generated from infrastructure and revitalization activities is the general population surrounding the work site. As an example, a 1991 sandblasting project on Interstate 45 bridges in Houston, Texas spewed lead particles over Buffalo Bayou and around downtown Houston, resulting in extremely high concentrations of lead in nearby vegetation (Bass, 1993). Although sufficient data is not available to quantify the risk to populations living or working in close proximity to infrastructure revitalization sites, a prudent approach would be to give consideration to this group, in addition to the DPW work force, in the Army’s lead-reduction strategy.

Family Housing Maintenance and Renovation

As of 1990, the number of Army family housing units totaled 195,000. Approximately 25 percent of the family housing units were 36 years old or older, another 50 percent were between 26 and 35 years old, and 25 percent were between 6 and 25 years old (EHSC, 1989). Many Army family housing units are known to contain LBP.

Remodeling and repair activities at Army family housing units can expose Army workers to lead. LBPs were used for interior and exterior painting of residences prior to their ban in 1978, and removal of such paint can expose Army workers to lead poisoning. DPW workers who paint, remodel, or repair units between occupancy cycles are at risk for lead exposure. In addition, plumbing repairs in Army family housing units (such as changing valve and pipe fittings or plumbing fixture fittings and brass trim) involve some risk of lead exposure.

Older family housing units containing leaded paint pose a risk of lead exposure to the occupants, especially children. The CDC has established the acceptable BLL for children at 10 µg/dl and calls for medical treatment at 25 µg/dl (CDC, 1991). There have been isolated cases of elevated BLLs in children at Fort Devens, Massachusetts; Presidio of San Francisco, California; and at Army installations in Panama, but the BLL data and the detailed case studies are not available. Personnel from the Army Surgeon General's Office stated that most of these children with elevated BLLs were living in off-base housing (Dope, 1993). Poorly cleaned buildings painted with LBP and older housing that had been renovated without proper safeguards were often the source of the lead (Dope, 1993). Army LBP-management programs have resulted in housing which presents very little exposure, as evidenced by Army statistics.

MWR Activities

Crafts and hobbies offered as part of the Army's MWR activities involve potential lead exposure. These include ceramics, pottery, kilning, stained glass window-making, photography, offset printing, lithography, silk screening, stenciling, gluing, woodworking, sewing, leather cutting, and laminating. The CDC considers hobbies to be one of the major risk factors for lead exposure in the home (CDC, 1991). Individuals who have taken their hobbies to a professional level may have a higher risk of exposure.

Ceramics, pottery, and stained-glass window making provide direct exposure: to lead or lead compounds. Potters and ceramists contact lead through paints, pigments, and glazes. In stained glass window-making, lead is present in the glass itself as well as in the matrix for joining the pieces of glass.

Professional photographers and hobbyists may be exposed to lead iodide and lead nitrate. Printers can be exposed to the lead in printing inks (lead iodide, lead nitrate, and lead sulfate) and in paints (lead acetate, lead antimonate, lead chromate, and lead thiocyanate).

Individuals who sew or work with textiles can be exposed to lead. Fabrics contain lead compounds in dyes (lead acetate, lead dioxide, lead chromate, and lead nitrate) and in coatings (waterproof fabric contains lead resinate, fireproof fabric contains lead silicate, lead sulfate is used in weighting fabric) (Lewis, 1993). Inhalation exposure occurs when particulates from the fabric coating or sizing get into the air during sewing operations.

Utilities and Services, Including Waste Management

Utility and service activities at by installations that involve potential lead exposure include drinking water supply and solid waste management.

The Army has 177 installations that provide their own potable water (Valcik, et al., 1993). The EPA monitoring results for lead in potable water from January 1993 indicate that five Army installations with systems serving 3,300 persons or more had lead concentrations greater than the 15 parts per billion (ppb) action level established by the EPA (AEPI, 1994). The highest lead concentration (85 ppb) was recorded at Fort Jackson, South Carolina. The other facilities that recorded elevated lead concentrations were Fort Bliss (44 ppb) and Fort Sam Houston (37 ppb) in Texas; Schofield Barracks (25 ppb), Hawaii; and Fort Drum (16 ppb), New York. The data currently available is inadequate to draw any general conclusions regarding the potential for lead exposure from potable water at Army installations. Lead in drinking water supplied by Army facilities effects the entire installation population, including high risk populations of women and children living in family housing on the installation.

The EPA report on the monitoring results for small- and medium-size systems indicates that five Army systems failed to meet the guidelines and six Army systems failed to report. Six of these 11 systems were not included in the CE-CPW Army database on installation-supplied water systems. The Army currently does not have a centralized data management system to compile monitoring results.

The Army operates both landfill sites and incinerators for solid waste disposal (Heller, 1993). However, given the high cost of complying with increasingly stringent environmental laws, Army installations are encouraged to use local municipal landfills when the life-cycle cost of municipal facilities is 125 percent of an Army owned and operated system (Offringa, 1991). In keeping with this policy, AR 420-47 encourages the use of municipal disposal facilities rather than building new landfills or incinerators on Army land.

Fifty-nine Army installations operate their own solid waste disposal facilities (i.e., recycling programs, incinerators, and/or landfills) (CE-CPW, 1991). Army incinerators include hazardous waste facilities, power plants, waste-to-energy facilities, and munitions disposal facilities (Heller, 1993). The Army has built seven municipal solid waste incinerators, and one is under construction (AEPI, 1992). Of the seven municipal solid waste incinerators, only three are still in operation. According to a recent Engineering and Housing Support Center survey, it is estimated that TRADOC, FORSCOM, and AMC currently have 51 active solid waste landfills on base and use 54 landfills located off Army property (EHSC, 1989). However, a majority of the on-base landfills are rapidly approaching their fill capacity (Griggs, 1991).

Military ordnance and ammunition, as well as other lead-containing materials such as lead-acid batteries, have been disposed of at landfills and waste disposal sites on Army installations. All waste disposal options for these materials introduce lead into the environment. Incineration residues contain lead, and emissions to the atmosphere are only prevented by using complex pollution-control measures. Landfilling provides an opportunity for lead to leach into

soils and makes it possible for lead to migrate into groundwater. Modem incinerators and landfills have been constructed to limit the migration of lead from the disposal site. Incineration facilities with less sophisticated emission controls and older landfills with no leachate collection systems pose the greatest threat of exposure to those living or working near a disposal site.

Materials that will be incinerated or disposed of in a landfill must be separated by hazard level according to EPA guidelines (Hauschild, 1993). Waste that leaches lead in excess of 5 mg/L, as determined by the TCLP, is considered hazardous and must be disposed of at a hazardous waste incinerator or a hazardous waste landfill [Agency for Toxic Substances and Disease Registry (ATSDR), 1992; U.S. Army Environmental Hygiene Agency (AEHA), 1993].

The 1993 HHIM database did not include information on occupational exposure from solid waste programs but did include information on 13 installations where lead exposure occurred through hazardous waste operations. The 1993 HHIM database listed hazardous waste operations that exposed 114 persons to lead; five were women. Approximately two-thirds of the waste disposal workers exposed to lead were civilian.

Demolition of Facilities and Infrastructure

Many Army barracks and housing facilities were painted with LBPs, and much of that paint remains on the buildings today. The demolition of these buildings, particularly World War II (WW II) buildings era or WW II "wood," thus involves potential lead exposure; special handling of the construction debris must be considered.

Current Army policy allows for whole-building construction debris to be characterized as nonhazardous under the following conditions:

- Hazardous components such as asbestos or PCBs are either not present or are disposed of separately.
- Metal components that can be removed are removed and salvaged for reuse or recycling.
- All remaining material (brick, concrete, painted wood, unpainted wood) is handled as a single unit and disposed of as a single unit.

All nonhazardous wastes can be sent to a construction-debris landfill for disposal as long as they meet criteria established by State and local agencies. The Army has developed a sampling procedure for whole-building debris and, relying on a statistical treatment of the data that recognizes the unique nature of the debris, facilitates waste characterization by the TCLP (Hauschild, 1993).

The hazardous waste materials that are segregated from the construction debris prior to the characterization of the whole-building waste are disposed of as hazardous waste if they have no reuse or recycle options. Hazardous waste incineration or disposal in an approved hazardous waste landfill are options for these materials.

Small-scale debris generated during demolition or during building renovation or repair must be treated differently from the whole-building debris and characterized separately (AEHA, 1993). This debris has a greater probability of being hazardous because of the presence of LBP; thus, steps must be taken to minimize this material. Separate treatment of the small-scale debris, such as door and window frames, painted trim, and molding, is necessitated by the proportion of the total surface likely to be painted and the large exposed surface area. The small-scale debris has a high potential for leaching lead and other toxic substances when it is landfilled.

Some WW II buildings have been demolished by burning. Burning these structures releases all the lead contained in the paint and possibly lead from other sources (i.e., lead pans used in showers and lead in fixtures and plumbing) into the environment. There does not appear to be any DOD or DA policy governing demolition by burning despite the possibility that lead will be deposited, in potentially very large quantities, into surrounding soils and waters.

Removal of Lead-Contaminated Soils

Soils which are heavily contaminated and which are being removed as a hazardous waste will typically be removed by contract employees who have adequate protection. However, there is a whole range of other activities involving the disturbance of soils which could provide exposure pathways. Activities such as range maintenance, grass mowing, excavation, and street sweeping can release lead contained in soil to the air. No data exist to determine the extent to which base operations staff are exposed; this is an area which would benefit from additional study.

On July 14, 1994, the EPA released guidance on dangerous levels of lead in interior household dust and bare residential soil. The EPA guidance specifies that soil lead concentrations above 400 ppm will require interim controls if the area contains bare soil and is used by children. The amount of investigation and extent of responses which will be required by this guideline remains to be determined.

State action and regulation of lead is likely as well. For example, Pennsylvania is now regulating lead in soil using a health-based standard. Once permissible levels of lead in the soil are exceeded, the soil is treated as a hazardous waste or as a residual waste. The cleanup level is based on a scenario where an adult worker is exposed via direct contact to the contaminated soil in an industrial setting (Killian, 1994).

It is likely that children coming into contact with lead contaminated soil are at some degree of risk; however, the risk to Army personnel and their families from lead in soil remains unknown. Army policy will be driven, at least in part, by State regulation as well as EPA regulation.

The full extent of lead exposure from lead-contaminated soil will require additional research. Should the Army adopt the recommendations in EPA's Section 403 Guidelines, the Army will have data which could be used to quantify the extent of potential exposure on Army installations.

Risk Assessment

USACHPPM data reveals the number of Army personnel potentially exposed to lead while engaged in base operations activities. One problem with assessing risk in base operations is that the data collected contains very little information on government contractors. Therefore, the full extent of health risk may not be apparent. Table F-1 shows the number of potential exposures by RAC for various categories of adults in the work force.

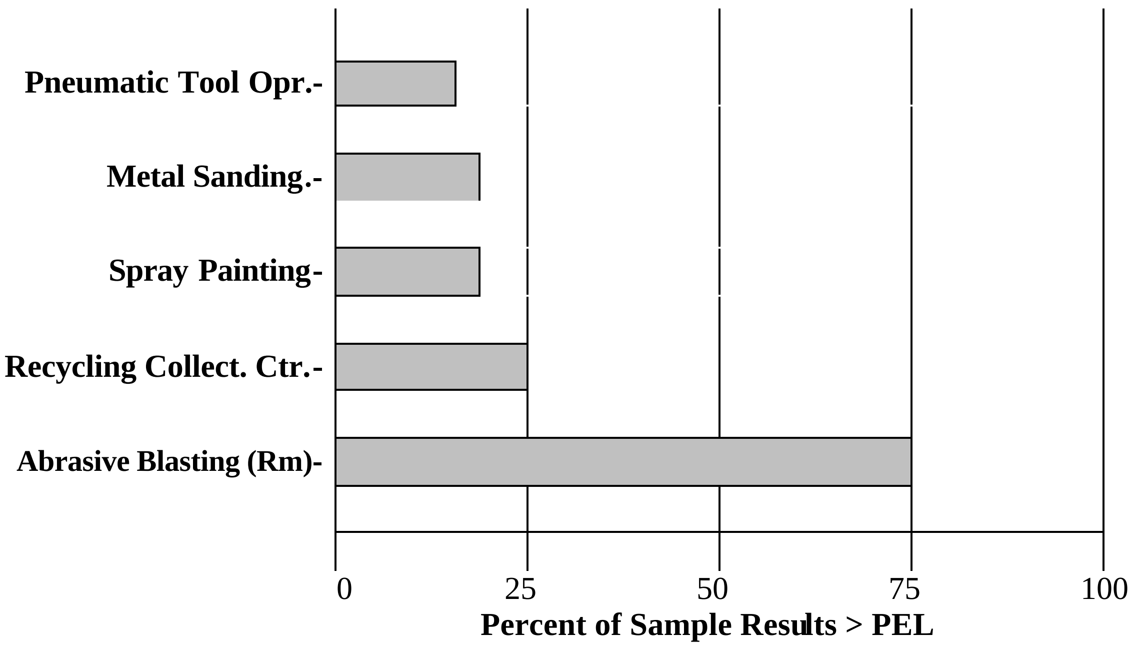
Table F-1. Exposure to Lead During Base Operations Activities

	# Exposed	Males	Females	Military	Civilian	Contractor
RAC 1	18	0	--	18	0	0
RAC 2	353	328	25	61	287	5
RAC 3	2,771	2,577	194	1,047	1,723	1

Numerous base operations activities can result in lead exposure. Those activities generate airborne-lead levels well above the OSHA PEL. These sample results would be considered a violation of Federal law, depending on the engineering controls and PPE used. HHIM information regarding the PPE and engineering controls used while collecting these airborne samples suggests that workers were not adequately protected from lead exposure in some instances. Information regarding specific operations performed without adequate controls is detailed in Appendix H.

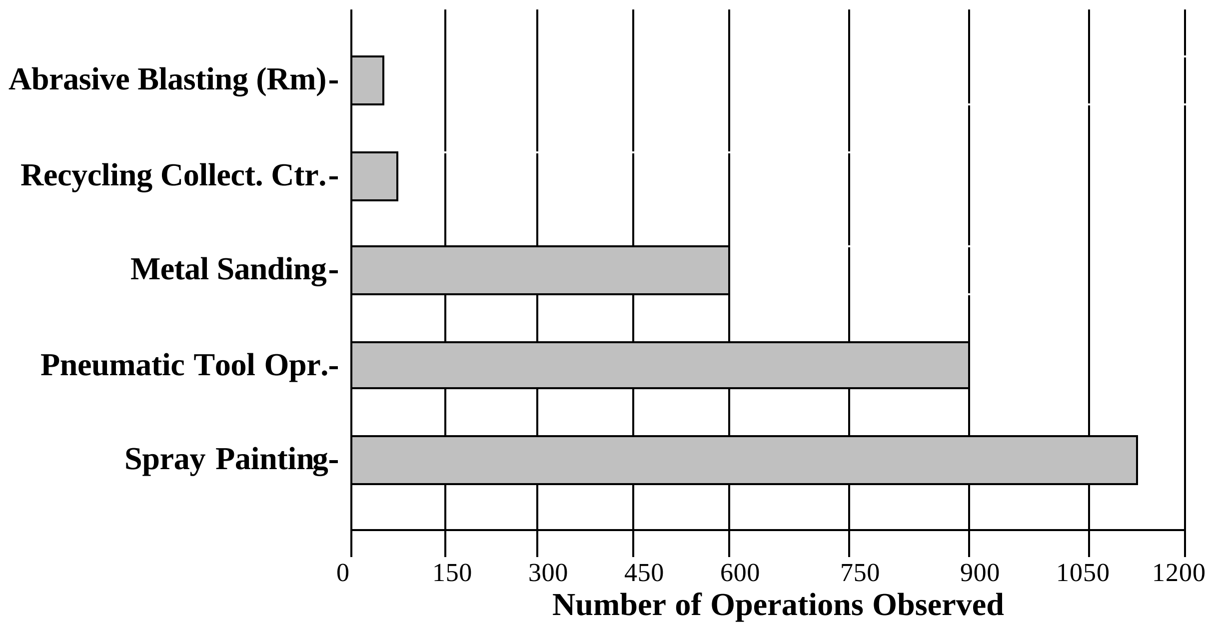
The activities selected for presentation in Figure F-1, rated with RACs of 1 (Critical) or 2 (Serious), are only a small portion of the base operations activities associated with lead. Other base operations activities that can result in exposure include decontamination, electrical parts repair, molten-metal pouring, kilning, and furnace operation.

Figure F-1. Base Operations
Percent of HHIM RAC 1 and RAC 2 Lead Air Sample Results
Exceeding the OSHA PEL



Although no firm estimate is available on the frequency with which lead-associated operations occur, Figure F-2 provides a conservatively low estimate of how often an operation occurs Army wide.

Figure F-2. Number of RAC 1 and RAC 2 Operations Observed or Surveyed Army Wide During 1994
Source: HHIM Database



The data provided by HHIM represent surveys or observations by Army industrial hygiene staff conducted in 1994. Although lead-air monitoring was not performed during each survey, the industrial hygienist specifically noted that the operation was taking place during a walk-through or more extensive survey. From the selected operations data presented in the graph, it is clear that thousands of tasks with potential lead exposure are taking place at Army installations each year. It is likely that the number of occurrences is higher than the frequency suggested for base operations activities in the graph.

No numerical weighting can be performed by combining the information presented in the graphs due to differing time periods (one year of data vs. multiple years), and the variation of control and cleanliness associated with the performance of the same task at different installations.

Risk-Reduction Strategy

The following sections provide a more detailed discussion of risk-reduction strategies in the various base operations areas.

Installations can take a variety of steps to implement a risk-reduction strategy for lead. Generally, they can take steps to avoid lead hazards, contain the lead, reduce the amount of lead used, substitute other material for lead, or eliminate lead entirely. Reducing risk in the area of base operations will require a complex mix of activities, some relatively easy to implement, and others requiring more difficult solutions. Installations could:

Avoid lead hazards by:

- Substituting brush painting for spray painting whenever possible.
- Repairing rather than replacing LBP on equipment.
- Developing a routine program for sampling potable water on military installations to analyze it for lead content.
- Ensuring that family members and soldiers participating in self-help projects or programs intended to maintain or improve facilities are educated in ways to avoid lead hazards.
- Educating the contracting and engineering staff on ways to write contracts which specify lead exposure will be minimized through appropriate controls.

Control lead hazards by:

- Advising Army personnel to limit the amount of time spent on hobby activities associated with lead exposure or to use PPE (e.g., masks, aprons, and gloves), and advising them to wash their hands with cold water immediately after such activity.
- Posting signs above craft and hobby areas that warn of lead-exposure dangers.
- Requiring workers to use PPE during sandblasting operations and other infrastructure revitalization projects where there is a risk of exposure to airborne-LBP particles.
- Providing on-the-job facilities for changing clothes and showering after performing work with potential or actual lead exposure.

- Providing family housing occupants with educational materials regarding the dangers of lead in potable water when lead levels are above the EPA guidelines. The educational materials should explain the risk of consuming first-draw water, inform users of steps being taken by utilities to reduce lead exposure, and recommend measures to reduce exposure.

- Maintaining a complete medical-monitoring program for all high-risk workers actually or potentially exposed to lead.

- Determining if LBP is on painted structures prior to performing maintenance work; ensuring appropriate safeguards are taken to protect workers and the surrounding community.

<u>Contain lead hazards by</u>:

- Providing local exhaust ventilation for metal-sanding operations.

- Providing adequate containment of lead-containing dust that becomes airborne when LBP is removed during infrastructure construction and revitalization activities.

- Conducting spray painting in facilities meeting applicable standards.

- Complying with OSHA standards for demolition of lead-containing structures.

- Reducing risks from sandblasting by using containment, vacuum blasting, wet-abrasive blasting, shrouded hand tools connected to vacuum, and chemical stripping.

- Segregating lead-containing waste found in demolition debris from other materials for recycling or proper disposal. This will decrease lead loadings in nonhazardous waste landfills or incinerators.

- Requiring recycling of lead-acid batteries, spent ammunition, and other lead-containing materials to decrease lead loadings in landfills or incinerators.

- Improving storage of lead-acid batteries at installation-collection points to prevent damage to the batteries which can result in lead releases.

Reduce the amount of lead used by:

- ❖ Restricting the use of lead-containing industrial and equipment paints and primers where possible.
- ❖ Procuring supplies and equipment with the least amount of lead content.
- ❖ Prohibiting the use of hardware and engineering materials which contain lead whenever possible.

Substitute other materials for lead by:

- ❖ Eliminating use of lead-containing plumbing fixtures, pipes, and solders in all plumbing applications (in addition to potable water supply).
- ❖ Ordering craft and hobby materials that do not contain lead, whenever feasible, although substitution may not be practical in some cases such as stained glass.
- ❖ Procuring lead-free paint for maintenance operations.

Eliminate the use of lead by:

- ❖ Eliminating abrasive-blasting procedures.
- ❖ Enforcing the ban on lead-containing paint in non-residential structures.

Lead Used During Base Operations

Most lead used during base operations is contained in paint and in building materials such as solder. Lead exposure can occur cluing a variety of facility construction, maintenance, and demolition activities. Implementing means to reduce or eliminate exposure requires the expenditure of resources, primarily for worker protection.

In 1991, the U.S. Department of Labor conducted an economic analysis of the proposed lead standard for the construction industry. While it is difficult to extrapolate precisely from this data to specific construction activities conducted during base operations, an estimate of the additional costs incurred to protect worker safety could be inferred from this report. The study found that:

> "The annual compliance costs per exposed worker range from $2,318 in cast iron, soil pipe, lead joint installation to $48,483 in underground storage-tank demolition. On a per affected establishment basis, the annual compliance costs range from $4,853 in preparation of linear acceleration suites to $145,488 in industrial process maintenance. Across all project types, the annual compliance costs per exposed worker and per affected establishment are estimated to be $10,111 and $34,433, respectively" (Department of Labor, 1991).

In this study, ''establishments" were defined as contractors conducting business under one of the following Standard Industrial Codes (SICS): SIC 15, General Building Contractors; SIC 16, Heavy Construction; and SIC 17, Special Trade Contractors. SICs are the statistical-classification standards, developed by the Office of Management and Budget, underlying all establishment-based Federal economic statistics classified by industry. The two-digit SIC defines broad industry, such as SIC 27: Printing, Publishing and Allied Industries, while the four-digit assignments are specific within an industry such as SIC 2752: Lithographic Commercial Printing.

The study indicates that a substantial part of the cost of lead use is the cost required to protect human health. The cost of compliance with OSHA regulations can be considerable, and any additional regulation, such as lowering PELS, could add to the cost. It is likely that compliance costs have been passed on to the Army in higher contract costs or incurred directly by the Army when Army employees are engaging in these activities.

The recently released EPA booklet, "Reducing Lead Hazards When Remodeling Your Home," although not a regulatory document, outlines procedures which could, if adopted as Army or building-trade procedures, add additional cost requirements to a variety of base operations maintenance activities (EPA, 1994). For example, the guide recommends that workers be protected from lead hazards while cutting, scraping, drilling, or sawing painted surfaces.

The DOD LBP Task Force is initiating efforts to capture the cost of lead hazard program requirements. This information should enable the Army to obtain more precise estimates of the cost of LBP use; the method used to gather this information may result in a model which could be used to gather cost data about other applications of lead (Nix, 1994).

To target resources to eliminate lead hazards, the Army should consider:

- ❖ Investigating the hazards to personnel working with lead-containing materials during routine maintenance activities.

- Eliminating entirely the use of lead-containing paint in industrial operations and facilities.

- Removing all LBP and lead-containing solder concurrently during family quarters and other facility renovation projects, as a way of eliminating lead-hazard protection requirements during routine maintenance.

Appendix G

Health and Medical Services

Sources of Exposure

Primary sources of exposure include:

- Dental procedures
- Dental impression chemicals
- Forming metal braces for prostheses
- Radiation therapy procedures
- Autoclave procedures
- Medical equipment maintenance procedures
- Ceramics
- Medical waste incineration
- Lead contamination in veterinary and hospital X-ray facilities
- Lead contamination in veterinary clinics and laboratories

Dental Procedures

Lead was formerly used as a dental-filling material. Although the practice has ceased, lead still in the patient's teeth presents a small potential exposure hazard to dentists. When fillings are changed (for reasons of health or filling condition), the drilling operation used to extract the lead filling presents a small hazard. The gloves and mask worn by all dentists to protect against biological hazards would serve to protect against lead exposure as well.

Metals and alloys are used for restorative dentistry, prosthetic dentistry, orthodontics, and dental techniques because of their chemical and physical properties such as hardness, strength, stiffness, toughness, resistance to corrosion, and biocompatibility. Dental materials containing metals and metal alloys include amalgams, impressions, fillings, crowns, bitewings, and bridges.

Chemicals used in fillings include lead, silver, copper, nickel, zinc, and mercury. The dental practices of foreign countries are more liberal in their use of lead in dental work.

The dental plates of foreign officers may serve as another source of lead exposure. While the frequency of encountering this is low at many installations, Fort Leavenworth provides dental services to the officers of at least 52 countries. When the dental plates are ground and reshaped, lead dust can be released. The grinding can be performed in a cabinet to lower exposure, but the clean-out procedures of the cabinet then present another opportunity for exposure.

Dental-Impression Chemicals

Materials comprising organic compounds used in dentistry include elastomers, polymers, and adhesives. Dentistry needs an elastic impression material that takes accurate, one-piece impressions of undercut areas (for inlay and crown preparations). Types of elastic impression materials include alginate-based, polysulfide, silicone, polyether, and agar. Precipitating compounds used in preparing the alginate-based materials include lead silicate and chromic sulfate. Lead peroxide is used in the polysulfide-containing base as a setting agent. Lead stearate may be used as an active retarder in the polymerization of liquid polysulfide polymers.

These lead-containing chemicals can act as a small source of exposure to the technicians preparing the dental pieces if good hygienic techniques are not employed.

Forming Metal Braces for Prostheses

A few selected Army MEDCENs have a Brace Shop to create custom braces required by patients. The shop staff will cast metal that may purposely contain lead, or lead may be a contaminant of the metal. The tasks of metal melting, metal casting, furnace use and clean out, and general shop housekeeping all may hold the potential for lead exposure. The potential for shop staff to be exposed is proportional to the lead content of the metal used for each brace. HHIM data document the potential lead exposure from casting, pouring, and grinding metal.

Radiation-Therapy Procedures

<u>Crafting Lead Bricks used for Radiation Therapy</u>

Therapeutic radiation requires the application of radiation on specific areas of the body. Specially crafted lead "bricks" are used to shield surrounding tissue while allowing radiation to pass through holes to the proper reception points. The lead melting, pouring, and shaping procedures used to make the bricks present potential lead-exposure hazards to the workers.

A few Army facilities will make the bricks from a lead-cadmium-bismuth-antimony alloy. Crafting the bricks requires cutting and filing the metal bricks and sweeping the shavings during housecleaning. This presents both ingestion and inhalation hazards.

Using Lead Bricks for Radiation Therapy

A few Army industrial hygienists reported that handling the lead bricks may present an ingestion hazard for the nuclear medicine and radioisotope pharmacy staff. The bricks are arranged by hand around the patient to shield particular areas of the body. A hand-to-mouth transfer can occur. The bricks are soft and can present an ingestion hazard if gloves and good hygienic practices are not used. Lead bricks are also used on the pharmacy bench-top to provide shielding while radioisotopes are handled by the pharmacy staff.

Autoclave Procedures

Autoclave procedures could result in lead exposure through ingestion. Sterilization of medical instruments by steam is performed in specially dedicated steam chambers known as “autoclaves.” Equipment and instruments are wrapped and sealed with tape to prepare for autoclaving. The tape serves as an indicator, turning from white to black when undergoing the high temperature sterilization. Certain brands of this indicator tape contain lead thus creating the potential for lead exposure. The tape can release lead onto the instruments or the hands of those who handle the tape.

Medical Equipment Maintenance Procedures

Maintenance activities specifically supporting the medical mission of an installation can result in lead exposure. These would include painting, plumbing, and soldering electrical components of medical equipment. These activities are described in Section 4.2.1 of this guide but are mentioned here to highlight the potential for lead exposure in a “safe” or “clean” environment of a MEDCEN. Since the Army medical system maintains its own logistical system: for medical items, medical equipment may be overlooked during installation prevention and occupational health programs.

Ceramics

Selected Army MEDCENs provide occupational therapy to patients. The ceramic pottery that is glazed and kilned in these therapy centers is a source of lead exposure to the patients and the staff who assist them. The risk of exposure is limited to this small group of people but can be a problem if the potential lead hazard is ignored.

Medical Waste Incineration

Waste generated from Army health and medical facilities fall into four general categories: municipal solid waste, regulated medical waste, hazardous waste, and low-level radioactive wastes. Of these four waste categories, Army facilities (like civilian facilities) generate significant amounts of municipal solid waste and regulated medical waste and only small amounts of radioactive and hazardous wastes. Incineration of these wastes (particularly solid waste) may result in occupational lead exposure for those who maintain and clean out the incinerators.

While the majority of the waste streams will not contain lead, small sources exist. Lead is a contaminant in many metals, including the hypodermic needles used in health care facilities. The “sharps” are specially contained and incinerated to reduce exposure to biological hazards. The incineration of the metal can create airborne-lead particles or create an exposure potential for the workers who must clean out the incinerator furnace (Malkin, 1992).

Another potential lead source is the red medical waste plastic bags. The red color comes from the presence of a red-lead pigment.

The MEDCOM does not possess actual waste generation figures for Army medical facilities, due to reporting variations at each facility; however, it is likely that Army hospitals generate waste at roughly the same rate as civilian hospitals. Studies conducted by the EPA indicate that hospitals generate approximately 5.6 pounds of waste per bed/per day. Using this formula, Army hospitals generate approximately 9,862,000 pounds of waste per year. Much of this waste is municipal waste which must be incinerated.

Medical waste is generated as a result of procedures used for the diagnosis and treatment of human diseases and for R&D of vaccines and medicines to treat these diseases. The definition of medical wastes varies from state to state, but the following categories capture most definitions: 1) cultures and stocks; 2) pathological wastes; 3) blood and blood products; 4) sharps; 5) animal waste; 6) isolation wastes; and 7) unused sharps (EPA, Report to Congress, 1990). While human blood and other body parts may contain trace elements of lead (because it is naturally found in the body), levels are too small to be considered significant.

Health care facilities generate a small amount of hazardous wastes and radioactive wastes. These wastes do not contain lead; their disposal does not result in any lead exposure.

The majority (nearly 70 percent) of hospitals in the U.S. use on-site incineration to treat medical wastes, but the type, nature, and use of incinerators varies significantly (EPA, Report to Congress, 1990). Most hospital incinerators are relatively old, single-chamber, batch-feed, excessive-air devices that do not allow for the complete material combustion. Some incinerators are used exclusively for disposing pathological waste; others are used to treat and dispose of

infectious and noninfectious medical waste. The MEDCOM reports that there are approximately 20 incinerators operating at Army facilities.

The incineration of municipal waste generated at health service facilities will result in the release of lead. The largest constituent of municipal waste which will result in lead releases is plastics. Toxic metals at medical waste incinerators come almost entirely from pigments and stabilizers in plastics. (EPA/530-SW-89-015B, 1989; Franklin Associates, Ltd., 1989; Lead Industries Association, 1991.) The materials which generated these releases in municipal waste incinerators are listed below:

- PVC plastic
- Electrical equipment
- Ceramics
- Lead in metal and glass
- Printing inks
- Packaging

One study indicated that lead in municipal incinerator ash from electrostatic precipitators is bioavailable and that the effects of such exposure can be minimized by wearing personal protective devices, not smoking, and rotating the work force to minimize precipitator ash contact (Malkin et.al., 1992).

Lead Contamination in Veterinary and Hospital X-Ray Facilities

The lead aprons used to shield X-rays are usually in excellent condition. The potential exists for lead leakage from aprons that have frayed with use and have gone unnoticed. This may occur in hospital or veterinary settings. If a small amount of lead leaks, it can be spread throughout an area by foot traffic. In general, veterinarians report receiving the lead gloves and aprons formerly used at the hospital. Some veterinarians reported that the gloves and aprons appeared frayed but are still used.

Lead Contamination in Veterinary Clinics and Laboratories

Veterinary clinics are similar to hospitals with respect to potential sources of 1ead exposure. Many veterinary clinics have autoclaves (and use the same indicator tape), some have

radiologic facilities (and handle lead bricks), and a very few have medical waste incinerators (with the associated lead-containing wastes and ash). All of these operations take place on a smaller scale and less frequently than in a hospital setting, suggesting a lower exposure risk.

Veterinary labs (as well as other research facilities) will sometimes use a lead-acetate solution during wet chemistry analysis. While chemists are usually quite careful in their work habits, the solution is a lead source that should be noted.

Some labs are also equipped with atomic absorption (AA) spectrometers, which are used for metal analysis. AA analysis of an environmental sample for lead involves the volatilization of a very small amount of lead. Properly exhausted AA spectrometers present a very low exposure risk to the volatilized metal.

In general, lead-exposure risk to the veterinary science staff is considered lower than that of the hospital staff based on the frequency with which lead associated tasks are performed.

Risk Assessment

Individuals working in military health care facilities risk lead exposure. While the opportunities for significant exposure are limited, the 1993 HHIM database identifies 363 people, at a total of 41 facilities, exposed to lead through medical and laboratory procedures. The activities involving lead exposure in a hospital setting are likely to be lower in risk than that of an industrial operation involving lead that takes place with greater frequency and involves a larger number of personnel. However, lead accumulates in the body over time and each low and infrequent exposure has a potential impact.

Although no precise estimate of the frequency with which lead-associated operations occur is available, Table G-1 provides a conservatively low estimate of how often an operation occurs Army wide. The numerical data provided by HHIM represent surveys or observations by an Army industrial hygiene staff conducted in 1994. Very little or no lead-air monitoring was performed during the surveys, but the industrial hygienist specifically noted that the operation was taking place during a walk-through, and a potential for lead exposure existed. While it is likely that the exposure levels are quite low, the activities still hold some risk for a few medical occupations. It is likely that the number of occurrences is higher than the frequency suggested for health and medical operations in the table.

USACHPPM data provide an estimate of the number of personnel potentially exposed to lead during health-related activities. These numbers originate from an incomplete database (HHIM), but provide a basis for estimating the number of people exposed:

Table G-1. Exposure to Lead During Health and Medical Activities

	# Exposed	Males	Females	Military	Civilian	Contractor
RAC 1	0	0	0	0	0	0
RAC 2	10	7	3	8	2	0
RAC 3	98	85	13	4	59	0

No operations were rated as RAC 1. Table G-2 shows the types of operations evaluated as RAC 2 and 3 activities.

Table G-2. RAC 2 and 3 Health and Medical Operations Associated with Lead Observed in 1994

Operation	Number of Observed Operations
General Health Care	1,465
Brush or Roller Application	809
General Dental Care	645
Laser Operations	248
Radiological Analysis	214
Metal Melting	30
Molten Metal Pouring	17

The HHIM database does not provide sufficient information to develop a full risk assessment. The hospital and medical settings are usually quite clean and free of any significant lead sources; this perception can allow the few personnel, such as the dental technician, or prosthetic brace-maker, who regularly come in contact with lead in the medical setting to go unnoticed. More data on exposed Army personnel are needed for a complete risk assessment. Answers to these questions are required to complete this analysis:

- How did the exposure occur?
- What was the length of exposure?

- What was the average exposure amount?
- Was the exposure a one time event or was it continuous?
- Was the exposure occupational or environmental?
- If occupational, what was the occupation of the individual?

Risk-Reduction Strategy - Installation Actions

Developing a risk-reduction strategy for health and medical activities will involve strict adherence to hygienic practices and material substitution. Little exposure data are present in the HHIM database for activities related to health and medical activities, so designating a more complete risk-reduction strategy will require additional investigation into possible lead hazards.

Given these constraints, installations can:

Avoid lead hazards by:

- Educating commanders, staffs, soldiers, and civilian employees about the lead hazards in the hospital and medical settings.
- Employing good hygienic and housekeeping practices when the staff is handling lead-containing materials; for example, cleaning operations of the kiln, brace shop, and dental workshop should be performed with great care.
- Wearing gloves when the radiation therapy staff handles the lead bricks; this will reduce the potential hand-to-mouth transfer of lead.
- Wearing gloves when using the autoclave-indicator tape; this will reduce the potential for hand-to-mouth transfer of lead.
- Controlling lead hazards resulting from maintenance on medical facilities.

Contain lead hazards by:

- Coating the lead bricks to contain the small amount of lead that may slough off with contact. If certain bricks are used repeatedly, dipping them or coating them with a nontoxic material, such as plastic, will eliminate the potential for lead to be picked up on the hands of the staff. A plastic cover could be easily cut away if the lead brick required reshaping. A zip-lock bag may serve this purpose as well.

- Using a glove box or cabinet when grinding, cutting, or filing lead-containing metal objects such as dental plates or bricks for radiation therapy.

- Regularly inspecting lead aprons for frays and tears.

- Using appropriate protective equipment and engineering controls when maintaining medical equipment containing lead on lead components.

- Avoiding incineration of lead-containing wastes.

Reduce the amount of lead use by:

- Using lead-free glazes in the occupational therapy kilns.

- Purchasing and using lead-free autoclave-indicator tape. In the mid-l980s, numerous brands contained lead; however, tapes with substitute materials may now be commercially available.

Eliminate processes which use lead by:

- Ensuring that facilities use hazardous waste bags that are lead-free. Some facilities are using lead-free bags, while others continue to use the type containing lead.

Risk-Reduction Strategy - DA Actions

Implementing Health and Safety Procedures for Those Handling Lead

Activities where lead is handled should have written health and safety procedures. Examples would include wearing gloves when the radiation therapy staff handles lead bricks and wearing PPE when the dental grinding cabinet is emptied. The health and safety procedures should be established through an industrial hygiene survey of the procedures. Existing policies

recognize the need to evaluate each job on an installation, but limited resources or the perception of the low exposure potential in a "clean" setting, such as a hospital, allows some tasks to proceed without a lead-exposure assessment.

All of the pertinent staff members should be trained in the established procedures. An example of differing procedures allows one hospital facility to continue using waste bags with lead pigment, while others have switched to a lead-free bag.

Reducing Lead Hazards by Waste Minimization

Waste minimization includes any action taken by a waste generator to decrease the amount or toxicity of waste generated. This can be accomplished through source reduction, reuse, and recycling. In the medical waste arena, Army facilities must take active steps to reduce the amount of waste generated.

Source reduction occurs prior to a waste generation activity. By implementing source reduction techniques, the amount of material purchased or produced will decrease and lessen the need for disposal of these wastes. Within a health care facility, proper purchasing decisions can achieve source reduction. These decisions will enable the facility to avoid those purchases that increase lead exposure.

Options for recycling are limited; however, many objects that have been used in patient care can be sterilized by autoclaving, thus rendering them safe for handling. Such examples are the disposable glass test tubes, cuvettes, and slides used for laboratory analyses. Another potential area for reuse is petri dishes. Because the dishes are glass, there is an opportunity to reprocess the dishes and prepare them for a new media. In addition, several types of devices are available to grind and chemically treat these items, rendering the used glass into disinfected shards suitable for recycling purposes. These actions will also lower lead exposure through a decreased need for incineration of these materials after use.

Investigating Alternative Forms of Waste Treatment

While incineration is the most prevalent form of treatment, there are new treatment technologies being developed and implemented at numerous health service industries across the country.

<u>Thermal Treatment Technologies</u>;

- ❖ Plasma Torch: In plasma torch reactors, infectious waste is "vaporized" at temperatures exceeding 3,000° F by applying highly ionized compressed air. A

plasma torch is an electric heater that uses the resistance of a highly ionized gas to convert electricity to heat. At this temperature, the molecular structure of the waste is chemically changed into "off-gases" and a "glass-like slag." The off-gases consist primarily of hydrogen and carbon monoxide, which after scrubbing can be used as an alternative fuel source (MHP, 1992). Lead releases for this technology equal 0.3 ppm.

The volume of gases produced by the plasma torch process is only one tenth that of incineration and can be burned as fuel. The high temperatures tend to minimize the production of dioxins and furans; however, air emissions contain heavy metals and hydrogen chloride, thus requiring advanced pollution controls.

- Pyrolysis: Pyrolysis converts infectious waste into gases and ash using high temperatures (ranging from 800 to 3,500 °F) in the absence of air. The resulting vapors are then treated in a second sealed chamber and oxidized at a temperature of 1,000 °C. The gases, which can vary in composition from carbon dioxide and water vapor to hydrogen and carbon monoxide, are filtered and scrubbed prior to discharge. An ash is produced, which represents less than 1 percent of the original waste volume and 2 percent of the original mass of the waste (MHP, 1992).

  Pyrolysis produces ash and can produce carbon monoxide. Testing has shown that the average lead-emission releases for this treatment are 368 milligrams per hour (mg/hr) (MHP, 1992).

<u>Other Treatment Technologies</u>:

Some R&D should be targeted against medical-specific waste streams. The MEDCOM could examine new treatment technologies, such as:

- Dry heat sterilization
- Plasma torch
- Pyrolysis
- Microwave irradiation
- Electro-thermal deactivation

<u>Reported Lead Releases</u>

Lead releases registered by various EPA reporting databases are shown in Table G-3. The Office of Air Quality, Planning, and Standards maintains the Aerometric Information

Retrieval System (AIRS); the Office of Solid Waste maintains the Biennial Reporting System (BRS); and the Office of Water maintains the Permit Compliance System (PCS). Information contained in these databases was collected from health care facilities reporting in the U.S. under certain environmental statutes. While this compiled information does not include military facilities, it does provide some indication of the releases expected from similar Army-owned facilities.

Table G-3. EPA Reported Lead Releases

Database	Type of Release	No. of Facilities	Total Releases (1b)
AIRS	Lead	357	30,801
BRS	Lead compounds	24	8,302
PCS	Lead	1	57

Appendix H

Control Measures to Reduce Occupational Lead Exposure

Control Practices and Options

The goal of any health or environmental program that considers lead will be to eliminate or control lead exposure. Where elimination or substitution cannot or has not occurred, control is the next best option. Engineering control measures which are installed or built into facilities are preferred over PPE or work-practice controls because they are less likely to be forgotten or ignored. This appendix reviews possible control options and the status of the Army's current control practices for lead-associated activities.

Existing Control Measures

Lead exposure occurs via inhalation and ingestion. While ingestion is best controlled by simple housekeeping and good hygiene practices, inhalation presents a hazard abated with more sophisticated measures, including engineering controls and respirators. It is common to find a combination of controls present at a single operation. Army policy as stated in TB MED 502 restricts the use of respirators to situations in which other methods to adequately control exposures are not feasible or for intermittent or emergency use.

Engineering Controls

Ventilation is the prime engineering control for lead. The three forms commonly used are:

- General Mechanical Ventilation (GMV) -- GMV is the general movement of room air by a typical air-conditioning system. It is effective for the slow reduction in vapor concentration of low-hazard chemicals. If the fan driving the system is powerful, it can be used to reduce, but not eliminate, airborne-lead concentrations in some situations such as indoor firing ranges.

- Local Exhaust Ventilation (LEV) -- LEV describes a ventilation system dedicated to removing a contaminant at the source of generation. An LEV can be designed into specific equipment, such as the vacuum system on a grinding wheel, or it can be mobile, such as the flex-hose exhaust positioned by a welder while working at the welding bench.

- Ventilated Booths -- Ventilated booths enclose the hazard and draw air and the airborne hazard away from the worker. They can range in size. The smallest may be the glove box used by the dentist while grinding dental pieces. (Some glove boxes are not ventilated but simply enclosed.) A paint-spray booth or walk-in, abrasive-blast booth are examples of larger systems.

Personal Protective Equipment

Respirators are the most effective type of PPE for reducing the potential for lead exposure. Respirators with a range of protection factors are available from manufacturers. Most use an HEPA filter, while others are masks connected to an independent air supply. An industrial hygienist selects respirators for a specific task based on the hazard (airborne-lead concentration) expected and the level of protection afforded by a respirator.

A paper dust mask is almost never sufficient for a task associated with lead exposure. A dust mask will keep paint chips from landing in the worker's mouth while chipping paint, but it will not reduce exposure to fine particles.

Half-face, negative air-pressure respirators provide the minimal level of protection required for most operations associated with lead. They can be used in environments with lead concentrations up to ten times the OSHA PEL. In dirtier situations, respirators with higher protection factors, such as full-face respirators, and powered, air-purifying respirators, can be used.

Airline respirators or self-contained breathing apparatus provide the highest level of protection. Airline respirators are commonly used in walk-in, abrasive-blasting booths.

Protective clothing reduces the risk of ingesting lead or spreading it outside the work area and to workers' homes.

The Status of Current Army Control Measures

The industrial hygiene data compiled in the HHIM demonstrates that a large majority of the surveyed operations are performed with the appropriate engineering controls and respiratory protection. The deficiencies documented in the database indicate that some workers may have been overexposed to lead because of insufficient engineering controls or PPE.

The HHIM data do not select a particular task as a "high-risk" operation. Due to variation in work habits, an operation performed safely one day, with no risk of exposure, may be the source of an overexposure the following day. A worker who performs the work properly

one day may neglect to turn the ventilation on or wear a respirator the next day, while repeating the operation. One installation may have designed the proper engineering controls around an operation, while another installation may allow the same operation to be performed in an uncontrolled manner. For this reason, no operation is permanently assigned a particular RAC code. Selected operations are presented below to illustrate the type of deficiencies occurring at Army installations:

Battery-Post Repair

Three of the four air samples collected during a battery-post repair operation were four times higher than the OSHA PEL. Both GMV and LEV were in use at the time. Respiratory protection is required for the operation, but no respirator was worn. This suggests that the engineering controls alone were insufficient to protect the worker and that the prescribed safety measures were not followed.

The HHIM notes that Tooele Army Depot requires respiratory protection during battery-post repair, while Fort Leonard does not. This suggests that either the engineering controls at Fort Leonard are sufficient or there is a need to standardize the standing operating procedures (SOPS).

Grinding

A half-face, negative air-pressure respirator is required, but high lead concentration sample data from HHIM suggests that this is insufficient, and a full-face or airline respirator may be more appropriate.

One installation (Letterkenny Army Depot) uses ventilation, while another organization (Georgia ARNG) does not. While some variation in requirements is expected, the grinding monitored at the Georgia ARNG produced very high lead levels without the protection of ventilation or respirators.

Lead Pouring Operation

Respiratory protection is required but was not worn during the operation, as noted during one industrial hygiene survey. While LEV and GMV were in use, the high airborne-concentration data indicate that failure to use respiratory protection resulted in an overexposure.

Brazing

A half-face, negative-air pressure respirator is required, but high lead concentration sample data from HHIM suggest that this is insufficient, and a full-face or airline respirator may be more appropriate.

Indoor Firing Ranges

The GMV required at all installations is clearly insufficient in some cases. Although the GMV is operating, lead exposures in excess of the OSHA PEL are occurring at some installations.

The operations above demonstrate that lead exposures are occurring at Army installations. Industrial hygiene and safety programs are in place but implementation deficiencies are resulting in incidences of potential overexposure.

Appendix I

Direct and Indirect Costs and Economic Analysis

Nature of the Economic Problem

As a commodity with numerous military applications, lead is an inexpensive, plentiful, and useful material. Its ready availability and suitability for recycling eliminate concerns about shortages or unreliable suppliers. For some applications, most notably lead-acid batteries, lead will remain the material of choice for the foreseeable future. While global demand is likely to increase, supplies of lead are likely to keep pace with demand because “dissipative” uses of lead (such as lead in gasoline, solder, paints, ceramics, and alloys) continue to decline. Opportunities for recycling abound, creating a closed-loop system for reuses of lead. Emerging policy for military ammunition containing lead appears to be moving toward a closed loop as well. Both current remediation technologies and emerging bullet-trap and bullet-backstop technologies provide an opportunity to recover most of the lead for recycling (McLaughlin, 1994; Fletcher, 1994).

As a commodity with toxic characteristics, lead is extensively regulated, and additional legislation and regulation seem likely. These regulations function as a sort of tax on lead use, driving up the cost of the basic commodity. Additional legislation will likely increase the “cost” of lead use, although in ways which are difficult to predict or quantify.

The economic problem for the Army, then, is one of balance -- to maximize the benefits of lead use while keeping cost to a minimum. Obtaining a rough estimate of the direct and indirect costs of lead use will be difficult primarily because of the changing regulatory environment at the State and Federal level. Cost estimates can become out-of-date as soon as a new regulation is promulgated.

A cost estimate model for lead should consider:

- Cost of the lead in the basic commodity;
- Cost of protecting human health while using the commodity;
- Cost of protecting the environment while using the commodity;
- Cost of disposal of the commodity; and
- Revenues from lead recycling.

This model would apply only to current, existing lead uses. It would not address the cost of cleanup or remediation of past commodity uses or future containment and cleanup requirements. For example, lead contamination in soil is coming under additional regulation; the cost of any remediation required would have to be added to the cost of the original lead use.

Given limited resources, the Army will want to carefully manage its lead-hazard management program and carefully target resources for maximum protection of human health and the environment.

To capture the cost involved lead use, the Army could consider analyzing the cost of major lead. These divide into four general uses: lead-acid batteries, ammunition, use in facilities, and use in supplies and equipment.

Appendix J

State Contacts for Additional Information on Lead

National Lead Information Center Hotline, 1-800-LEAD FYI

ALABAMA
Donna Hanes or Anic Lopez, R.N. – 205-242-5661
Dr. Charles Woemle - 205-242-5131

ALASKA
Linda Himmelbauer - 907-465-5152

ARIZONA
Cecile Fowler - 602-542-7306

ARKANSAS
Dr. Bob West - 501-661-2592
Patsy Lewis - 501-661-2592

CALIFORNIA
Robert Schlag - 510-450-2424
Childhood Lead Poisoning Prevention Program - **1-800-LA4-LEAD**

COLORADO
Amy Johnson - 303-692-2636
Michelle Bolyard - 303-692-3539

CONNECTICUT
Debby Lafferty - 203-566-5808

DELAWARE
Lisa Marencin - 302-739-4735
Wilmington - 302-995-8693

DISTRICT OF COLUMBIA
Ella Witherspoon - 202-727-9870

FLORIDA
Call your local HRS or
Roger Inman or Joseph Sekerke - 904-488-3385
Anne Boone - 904-488-9228
Pinellas County
Melanie Thoenes - 813-824-8900

GEORGIA
Ms. Tommie Bradford - 404-657-6534
Fulton County
Dr. Levonne Painter - 404-730-1491

HAWAII
Hilda Kitagawa - 808-832-5860

IDAHO
Steve West, Environmental Health - 208-334-6584
Panhandle Health District
Jerry Cobb - 208-752-1235

ILLINOIS - 1-800-545-2200
Melinda Lehnherr or Jonah Deppe - 217-782-0403
Kankakee County -
Val Messier - 815-937-7866
Janice Marshall - 815-937-3565

INDIANA
David Ellsworth - 317-633-0662

IOWA - 1-800-972-2026
Ken Choquette - 515-281-8220
Rita Gergely - 515-242-6340

KANSAS
Steve Paige - 913-296-0189
Dick Morrissey - 913-296-1343
Dr. Andrew Pelletier - 913-296-6215
Environmental Health Services

KENTUCKY
Ann Johnson, Sarah Wilding, or
Pat Schmidt - 502-564-2154
Northern Kentucky
Bill Bookmeyer - 606-581-3888
Cathy Winston - 606-341-4264
Lexington-Fayette
Zaida Belendez, Carol Vaughn, or
Janice Hollen - 606-288-2434
Louisville-Jefferson
Judy Nielsen or
Connie Huber - 502-574-6644

LOUISIANA
Eve Flood, Office of Public Health -
504-568-5070

MAINE
Edna Jones, Public Health Nursing -
207-287-4311
David Breau - 207-287-5694

MARYLAND
Childhood Lead Poisoning Prevention
Program - 410-631-3859

MASSACHUSETTS
Merrimack Valley
Carmen Torres - 508-681-4940
Worcester
Frank Birch - 508-799-8589
Southeastern Mass U.
Carmen Maiocco - 508-999-9930
Boston
Ngozi Oleru, Public Information
Officer - 617-534-5965
Springfield
Dolores Williams, Ph.D. - 413-787-6717
Salem Hospital
Phyllis Groskin or Carrandra
Farguheson - 508-745-2100, ext. 2774
Lowell
Joan Seeler - 508-970-2470
Avon
Frances Olson - 508-588-0447
Barnstable - Sean O'Brien - 508-362-2511
If you do not live in these areas,
call **1-800-532-9571**

MICHIGAN
Lansing
Alethia Carr, Paulette Dunbar -
517-335-9263
Jim Bedford - 517-335-9215
Detroit
Harriett Billingslea - 313-876-4212

MINNESOTA
Douglas Benson - 612-627-5017
Dianne Kocourek Ploetz - 612-627-5018
City of St. Paul
Lynn Bahta - 612-292-7747
City of Minneapolis
Brian Olson - 612-673-3595

MSSISSIPPI
Ernest Griffin - 601-960-7463

MISSOURI - 1-800-392-7245
William Schmidt, Daryl Roberts, or
Kenneth Duzan - 314-751-7834
Department of Natural Resources

MONTANA
Todd Damerow - 406-444-3986

NEBRASKA
Rita Westover - 402-471-0197
Dr. Adi Pour - 402-471-2541

NEVADA
Jeff Fontaine - 702-687-6615

NEW HAMPSHIRE
Martha Turner Wells - 603-271-4507
George Robinson - 603-271-4668
Todd Leedburg - 603-271-2942
Richard Thayer, Jr. - 603-271-3139
City of Manchester - 603-624-6466

NEW JERSEY
Kevin McNally - 609-292-5666
Danuta Budzygan - 609-588-2739
Bob Tucker - 609-984-6070
Burlington Co.
Harriet Stewart - 609-267-1950, ext. 2832
Camden County
John Costello - 609-757-0021
Cumberland County -
Laurie Geremia, R.N. - 609-794-4264

NEW JERSEY - continued
Essex County
East Orange - 201-266-5489
Irvington - 201-399-6651
Newark - 201-733-7547 or 201-456-5032
Orange - 201-266-4077
Gloucester County
Delle Zelinsky - 609-853-3437
Hudson County
Madeline Brown - 201-547-4567
Middlesex County
Joan Pisuk - 908-521-1402
Nina Benton - 908-745-6663
Monmouth-Ocean Co.
Jeryl Krautle - 908-431-7456
Dr. Theresa Comfroy - 908-341-9700
Passaic County
Majorie Pacheco - 201-881-6919
Trenton
Sharon Winn - 609-989-3204
Union County
Barbara Parker - 908-289-8600
Imelda Chukwu - 908-753-3500

NEW MEXICO
Dan Merians - 505-827-0006

NEW YORK
Nancy Robinson, James Raucci, or
Marie Miller -518-473-4602
Patrick Parsons -518-474-5475
Westchester County
Donna Bernard - 914-593-5203
New York City - 212-BAN-LEAD
Water Test, NYDEP - 718-699-9811
Department of Housing, Preservation, and
Development - 212-960-4800

NORTH CAROLINA
Ed Normans - 919-733-0385
James Hayes - 919-733-2884

NORTH DAKOTA
David Cunningham or Sandra Anseth - 701-224-2493
Ken Kary - 701-221-2169
Mike Borr - 701-221-6143
Dana Mount or Ken Wangler - 701-221-5188

OHIO - 614-644-0524
Phil Hyde - 614-644-1894
Cleveland
Wayne Slota - 216-664-2175
Columbus
Gary Garver - 614-645-6129
Mahoning County
Karla Krodel - 216-788-7571
Cincinnati
Shirley Wilkinson - 513-352-3052

OKLAHOMA
Dr. Edd Rhoades - 405-271-4471
Monty Elder - 405-271-7353

OREGON
Margot Barnett, Oregon Health Division - 503-731-4025

PENNSYLVANIA
See your physician or contact your local State health center.
Lead Poisoning Programs:
Allegheny - 412-823-3120
NE Pennsylvania **- 1-800-662-5220**
Harrisburg - 717-782-2884

RHODE ISLAND
Dr. Peter Simon or Cathy O'Malley - 401-277-2312
Cheryl LeClair - 401-277-1185, ext. 145

SOUTH CAROLINA
Columbia
Kelli Kenison or Cynthia Wright - 803-737-4061
Charleston
Jackie Dawson - 803-724-5814

SOUTH DAKOTA
Rex Vanderberg - 605-773-3364

TENNESSEE
Dr. Robert Taylor - 615-741-5683

TEXAS - 1-800-422-2956
Galveston
Dr. Wayne R. Snodgrass - 409-772-3332
Dallas
Dr. Alice Pita - 214-670-7151
San Antonio
Dr. Michael Foulds - 512-270-3971
Houston
Dr. Marcus Hanfling - 713-793-2592
Sonja A.Vodehna1- 713-794-9349

UTAH
Dr. Denise Beaudoin - 801-538-6191
Richard Clark - 801-538-6855
Wayne Pierce - 801-584-8400

VERMONT - 1-800-439-8550
Karen Garbarino - 802-865-7786

VIRGINIA - 1-800-523-4019
Eileen M. Mannix - 804-786-7367
Edward Lefebvre - 804-786-3766
Jack Proctor - 804-786-5041
Central Virginia
Dr. Edward Hancock - 804-947-6777
Crater Health District
Daphne Horner - 804-861-6582
Norfolk Health District
Kris Meek - 804-683-2862
Portsmouth Health District
Susan Strong, R.N. - 804-393-8585, ext. 152
Richmond Health District
Yvonne Johnson - 804-780-4240
Fairfax County - 703-246-2411

WASHINGTON
David F. Nash - 206-753-2730

WEST VIRGINIA
Cathy Hayes - 304-558-0197

WISCONSIN
Mark Chamberlain, Abatement - 608-266-7897
Jody Diedrich, Medical - 608-266-1826
Joe Schirmer, General 608-266-5886
Patty Bolig, Laboratory - 608-266-5817
City of Milwaukee - 414-225-LEAD

WYOMING
Todd Klietz, Department of Health - 307-777-7957

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The National Lead Information Center is operated by the National Safety Council with funding from the Environmental Protection Agency, the Centers for Disease Control and Prevention, and the Department of Housing and Urban Development.
If you cannot be assisted by your State and have a specific question, please call 1-800-424-5323 or 202-833-1071.

Appendix K

National Lead Information Resource List

Alliance to End Childhood Lead Poisoning: 202-543-1147

National nonprofit public interest organization created to launch a comprehensive attack on the epidemic of childhood lead poisoning. Provides information on current and pending Federal legislation and regulations. Also distributes a number of publications on current lead-poisoning prevention issues and a bimonthly newsletter.

American Industrial Hygiene Association (AIHA): 703-849-8888

Administers a laboratory proficiency program for lead testing in paint chips, soil, and dust wipes designed by EPA. Laboratories may participate in the Environmental Lead Proficiency Analytical Testing program by calling AIHA.

Center for Disease Control and Prevention (CDC), Lead-Poisoning Prevention: 404-488-7330

Provides technical assistance for childhood lead-poisoning prevention programs and distributes lead-related publications.

U.S. Department of Housing and Urban Development (HUD), Office of Affordable Housing Programs, HOME Information Center: 1-800-998-9999

The Center provides information on funding sources, both public and private, for affordable housing and case studies highlighting strategies to develop and rehabilitate affordable housing. The Center also provides printed materials on HOME, HOPE 3, CHAS and upcoming training and conferences on affordable housing.

U.S. Department of Housing and Urban Development (HUD), Office of LRP Abatement: 202-755-1822

Provides information on HUD LRP grant programs and initiatives. Offers technical support on housing issues.

HUD User: 1-800-245-2691

This service provides HUD documents to the public. The LBP materials they distribute include EPA's abatement training curriculum.

National Center for Lead-Safe Housing: 410-992-0712

Provides technical assistance for lead hazard control in housing.

National Institute for Occupational Safety & Health (NIOSH): 1-800-356-4674
Primarily serves professionals concerned with occupational exposure to lead. Issues of most concern are lead smelting, recycling, and radiator repair. Workers may request a workplace (i.e. health hazard) evaluation.

National Safety Council, National Lead Information Center Hotline: 1-800-LEAD FYI
Supplies a basic information packet to the public free of charge on lead poisoning and prevention through a 24-hour automated response system.

National Safety Council, National Lead Information Clearinghouse: 800-424-LEAD
Provides technical information and answers to specific lead-related questions for private citizens and professionals.

National Sanitation Foundation: 313-769-8010
Independent, nonprofit organization that provides information on water filtration methods and devices.

National University Continuing Education Association (NUCEA): 202-659-3130
Manages a network of the Regional Lead Training Centers. Provides a newsletter and information on the Centers' activities and course offerings. The regional centers are EPA-sponsored course providers for supervisors and contractors, lead inspection training, and train-the-trainer courses. Call for registration and scheduling information and satellite center locations.
Mideastern and Atlantic Regional Lead Training Centers:
Cincinnati, Ohio: 513-558-1729; Baltimore, Maryland: 410-706-1849
Midwest Regional Lead Training Center: Overland Park, Kansas: 913-897-8500

U.S. Environmental Protection Agency, Safe Drinking Water Hotline: 1-800-426-4791
Provides assistance and regulatory information to the regulated community (public water systems) and the public on regulations and programs developed in response to the Safe Drinking Water Act.

U.S. Environmental Protection Agency, Small Business Ombudsman Clearinghouse and Hotline: 1-800-368-5888
Assists small business in compliance with EPA regulations.

U.S. Environmental Protection Agency, Toxic Substances Control Act (TSCA) Hotline: 202-554-1404

Provides information on programs under TSGA, Asbestos School Hazard Abatement Act, and Asbestos Hazard Emergency Response Act. Provides assistance to the general public and the regulated community by distributing copies of documents, brochures, booklets, and FR announcements.

Water Quality Association: 708-505-0160

Nonprofit organization that provides independent information on water filtration methods and devices.

Appendix L

20 July 1994 HHIM Database for Lead Exposure (Sorted by Mission Area)

TRAINING AND READINESS								
RAC	**Operation**	**Installations**	**# Exposed**	**Male**	**Female**	**Military**	**Civilian**	**Contractor**
1	Battery post repair	1	9	9	0	0	9	0
1	Firefighting	1	47	45	2	0	47	0
2	Firefighting	1	28	27	1	0	28	0
1	Indoor firing ranges	1	2	2	0	2	0	0
2	Indoor firing ranges	7	29	28	1	19	10	0
3	Indoor firing ranges	8	28	24	4	14	14	0
2	Welding operations	10	100	100	0	30	70	0
3	Brake relining	3	116	107	9	114	2	0
2	Charging	4	22	21	1	6	16	0
2	Classroom training	1	2	2	0	2	0	0
3	Classroom training	1	5	3	2	0	5	0
2	Engine rebuild	3	29	26	3	3	26	0
3	Other	2	57	54	3	44	13	0
2	Radiator repair	5	16	16	0	6	10	0
3	Shot blasting	2	6	6	0	0	6	0
2	Weapons repair	2	13	12	1	11	2	0
2	Weapons firing	10	54	52	2	15	39	0
3	Weapons firing	16	384	329	55	184	200	0
3	Diving	1	5	5	0	5	0	0

TRAINING AND READINESS								
RAC	**Operation**	**Installations**	**# Exposed**	**Male**	**Female**	**Military**	**Civilian**	**Contractor**
RAC 1 Subtotals			58	56	2	2	56	0
RAC 2 Subtotals			293	284	10	92	201	0
RAC 3 Subtotals			601	528	73	361	240	0
Totals			952	868	85	455	497	0

LOGISTICAL OPERATIONS								
RAC	**Operation**	**Installations**	**# Exposed**	**Male**	**Female**	**Military**	**Civilian**	**Contractor**
3	Aviation maintenance	7	108	102	6	77	31	0
3	Avionics maintenance	5	155	136	19	151	4	0
2	Body repair	2	6	6	0	0	6	0
2	Brake relining	1	3	3	0	0	3	0
3	Charging	13	266	255	11	154	112	0
3	Electrical parts repair	27	676	632	44	468	208	0
1	Fork-lift operations	2	9	8	1	0	9	0
2	Fork-lift operations	1	13	13	0	0	13	0
3	Fork-lift operations	2	14	14	0	0	14	0
1	Instrument calibration	1	1	1	0	0	1	0
3	Instrument calibration	8	94	89	5	20	74	0
1	Load-unload misc items	1	13	10	3	0	13	0
3	Load-unload misc items	2	42	37	5	13	29	0
1	Metal sanding	1	2	2	0	0	2	0
2	Metal sanding	3	67	65	2	16	51	0
3	Metal sanding	8	39	38	1	16	23	0
1	Mixing, bagging, and handling	1	8	8	0	8	0	0
1	Other	1	7	7	0	0	7	0
1	Quality control	1	1	1	0	0	1	0
3	Quality control	2	29	25	4	0	29	0
2	Soldering	2	32	29	3	2	30	0
3	Soldering	23	496	448	48	224	272	0
1	Sandblast cabinet	1	1	1	0	0	1	0
3	Spray painting	9	38	38	0	19	19	0

LOGISTICAL OPERATIONS								
RAC	**Operation**	**Installations**	**# Exposed**	**Male**	**Female**	**Military**	**Civilian**	**Contractor**
2	Inert gas	1	10	10	0	0	10	0
3	Inert gas	2	7	7	0	4	3	0
2	Other	6	23	19	4	10	13	0
3	Other	8	173	157	16	92	81	0
2	Paper-shredding handling	1	6	6	0	0	6	0
3	Radiator repair	13	72	69	3	45	27	0
3	Dispensing-handling of POL	5	325	255	70	314	11	0
3	Storage	1	41	36	5	25	16	0
3	Storage and handling	8	50	43	7	8	42	0
3	Tool room	1	21	21	0	0	21	0
2	Testing and tuning	3	22	21	1	0	22	0
2	Tire repair	1	9	8	1	0	9	0
3	Weapons repair	1	123	113	10	110	13	0
3	Welding operations	24	535	518	17	271	264	0
RAC 1 Subtotals			42	38	4	8	34	0
RAC 2 Subtotals			191	180	11	28	163	0
RAC 3 Subtotals			3304	3033	271	2011	1293	0
Totals			3537	3213	286	2047	1490	0

INDUSTRIAL OPERATIONS								
RAC	**Operation**	**Installations**	**# Exposed**	**Male**	**Female**	**Military**	**Civilian**	**Contractor**
1	Abrasive blasting (indoor)	1	3	3	0	0	3	0
2	Abrasive blasting (indoor)	2	20	20	0	0	20	0
3	Abrasive blasting (indoor)	4	6	6	0	0	6	0
1	Aerosol can painting	1	2	2	0	0	2	0
2	Aerosol can painting	2	40	36	4	12	28	0
3	Aerosol can painting	11	158	150	8	50	108	0
1	Arc welding	1	4	4	0	0	4	0
2	Arc welding	2	6	51	1	5	1	0
3	Arc welding	9	51	51	0	38	13	0
1	Assembly-disassembly	1	7	4	3	0	7	0
2	Assembly-disassembly	1	18	16	2	0	18	0
3	Assembly-disassembly	7	178	168	11	0	179	0
3	Battery post repair	14	150	146	4	77	73	0
3	Body repair	10	155	152	3	6	149	0
1	Brush or roller application	1	2	2	0	0	2	0
3	Brush or roller application	6	51	49	2	26	25	0
1	Chemical analysis	1	38	36	2	0	38	0
3	Chemical analysis	3	38	33	5	0	38	0
1	Compressed-air cleaning	1	15	11	4	0	15	0
2	Compressed-air cleaning	1	25	21	4	0	25	0
3	Compressed-air cleaning	2	40	33	7	0	40	0
1	Crane operation	1	3	3	0	0	3	0
3	Crane operation	1	13	13	0	0	13	0
1	Dip-tank cleaning	1	10	7	3	0	10	0

INDUSTRIAL OPERATIONS								
RAC	**Operation**	**Installations**	**# Exposed**	**Male**	**Female**	**Military**	**Civilian**	**Contractor**
3	Dip-tank cleaning	2	10	10	0	0	10	0
1	Electrical-parts repair	1	1	1	0	0	1	0
3	Engine rebuild	6	169	160	9	120	49	0
1	Explosive-chemical manufacture	1	6	2	4	0	6	0
2	Explosive-chemical manufacture	2	14	14	0	0	11	3
1	Gas metal arc welding	1	2	2	0	0	2	0
2	Gas metal arc welding	1	3	3	0	0	3	0
3	Gas metal are welding	2	10	8	2	0	10	0
1	Gas tungsten arc welding	1	2	2	0	0	2	0
1	Grinding	2	5	5	0	0	5	0
2	Grinding	7	125	113	12	7	118	0
3	Grinding	17	374	349	25	184	190	0
1	Lead-pouring operation	1	9	9	0	0	9	0
3	Lead-pouring operation	6	64	61	3	22	42	0
1	Manual wiping	2	18	15	3	0	18	0
2	Manual wiping	1	26	22	4	0	26	0
3	Manual wiping	3	42	37	5	0	42	0
1	Oxyacetylene	2	10	9	1	0	10	0
2	Oxyacetylene	1	13	13	0	0	13	0
3	Oxyacetylene	7	64	64	0	48	16	0
1	Oxyfuel-gas welding	1	3	3	0	0	3	0
2	Oxyfuel-gas welding	1	7	7	0	0	7	0
3	Oxyfuel-gas welding	2	11	11	0	7	4	0
1	Pneumatic-tool operation	1	3	3	0	0	3	0

INDUSTRIAL OPERATIONS								
RAC	**Operation**	**Installations**	**# Exposed**	**Male**	**Female**	**Military**	**Civilian**	**Contractor**
2	Pneumatic-tool operation	3	4	4	0	0	4	0
3	Pneumatic-tool operation	1	26	23	3	0	26	0
1	Safety-industrial hygiene survey	1	3	3	0	0	3	0
2	Safety-industrial hygiene survey	2	3	1	2	0	3	0
3	Safety-industrial hygiene survey	2	13	12	1	0	13	0
2	Shot blasting	1	6	6	0	0	6	0
1	Soldering	4	22	15	7	0	22	0
2	Soldering	2	36	34	2	0	36	0
3	Soldering	7	187	171	16	22	165	0
1	Spray painting	2	5	3	2	0	5	0
2	Spray painting	5	48	41	7	3	44	1
3	Spray p ainting	13	218	199	19	44	174	0
1	Surface treating	1	13	10	3	0	13	0
3	Testing and tuning	19	1382	1239	143	1284	98	0
1	Welding operation	2	8	8	0	0	8	0
2	Welding operation	2	21	19	2	11	10	0
3	Welding operation	10	48	47	1	2	46	0
2	Brazing	1	11	11	0	0	11	0
3	Brazing	3	5	5	0	0	5	0
2	Environmental testing chamber	1	8	8	0	0	8	0
2	Glassbead blast	1	31	31	0	0	31	0
2	Hand shaping and cutting	1	1	1	0	0	1	0
3	Hand shaping and cutting	1	22	20	2	0	22	0

INDUSTRIAL OPERATIONS								
RAC	**Operation**	**Installations**	**# Exposed**	**Male**	**Female**	**Military**	**Civilian**	**Contractor**
2	Incendiary manufacturing	1	1	1	0	0	1	0
3	Incendiary manufacturing	2	14	12	2	0	14	0
2	Laser operations	1	6	4	2	0	6	0
3	Laser operations	3	29	27	2	5	24	0
2	Machining	1	20	20	0	0	20	0
3	Machining	7	105	100	5	3	102	0
2	Molding or extruding	1	3	3	0	0	3	0
3	Molding or extruding	1	2	2	0	0	2	0
3	Other	7	75	66	9	0	75	0
2	Shielded metal arc welding	1	9	8	1	0	9	0
3	Cast cleaning-finishing	1	1	1	0	0	1	0
3	Dip coating	2	11	11	0	0	11	0
3	Drilling	4	47	44	3	1	46	0
3	Electrical-parts repair	8	137	126	11	6	131	0
3	Electrostatic spray	1	9	9	0	0	9	0
3	Honing metal or wood	1	22	20	2	0	22	0
3	Metal melting	1	2	2	0	0	2	0
3	Mixing, bagging and handling	1	6	6	0	0	6	0
3	Plasma arc welding-cutting	1	3	3	0	0	3	0
3	Plating	4	93	81	12	0	93	0
3	Quality control	3	8	7	1	0	8	0
3	Sandblast cabinet	1	1	2	0	0	1	0
3	Ultrasonic cleaning	1	2	2	0	0	2	0

INDUSTRIAL OPERATIONS								
RAC	**Operation**	**Installations**	**# Exposed**	**Male**	**Female**	**Military**	**Civilian**	**Contractor**
RAC 1 Subtotals			194	162	32	0	194	0
RAC 2 Subtotals			505	462	43	38	466	1
RAC 3 Subtotals			4053	3737	316	1945	2108	0
Totals			4752	4361	391	1983	2768	1

BASE OPERATIONS								
RAC	**Operation**	**Installations**	**# Exposed**	**Male**	**Female**	**Military**	**Civilian**	**Contractor**
2	Battery-post repair	1	35	32	3	8	27	0
1	Cleaning-sweeping	1	1	0	1	0	1	0
3	Cleaning-sweeping	2	34	24	10	0	34	0
1	Multiple operations	1	1	1	0	0	1	0
2	Multiple operations	2	10	10	0	0	8	2
3	Multiple operations	17	365	334	31	84	280	1
1	Spray painting	1	1	1	0	0	1	0
2	Spray painting	5	9	9	0	2	6	1
3	Spray painting	20	313	121	10	33	98	0
2	Asbestos handling	1	13	10	3	0	11	2
2	Ceramics work	4	15	7	8	8	7	0
3	Ceramics work	8	20	7	13	0	20	0
2	Microwave communications	2	11	11	0	5	6	0
3	Microwave communications	4	86	69	17	74	12	0
2	Construction	1	2	2	0	0	2	0
3	Construction	4	23	23	0	10	13	0
2	Decontamination	1	1	1	0	0	1	0
2	Dip-tank cleaning	2	6	6	0	1	5	0
3	Dip-tank cleaning	1	11	11	0	11	0	0
2	Electrical generator	1	3	3	0	0	3	0
3	Electrical generator	1	6	6	0	4	2	0
2	Explosive disposal	1	4	4	0	0	4	0
3	Firefighting	1	29	29	0	0	29	0
2	Furnace operations	1	6	6	0	0	6	0

BASE OPERATIONS								
RAC	**Operation**	**Installations**	**# Exposed**	**Male**	**Female**	**Military**	**Civilian**	**Contractor**
2	General plumbing	1	14	13	1	0	14	0
3	General plumbing	17	152	152	0	15	137	0
2	Generator repair	1	1	1	0	0	1	0
3	Generator repair	5	34	27	7	23	11	0
2	Electrical-parts repair	2	8	7	1	0	8	0
2	Hazardous-spill cleanup	1	13	13	0	0	13	0
3	Hazardous-spill cleanup	1	9	9	0	0	9	0
2	Hazardous-waste operations	3	26	25	0	8	18	0
3	Hazardous-waste operations	4	36	31	5	0	36	0
2	Maintenance	4	26	26	0	0	26	0
3	Maintenance	25	483	463	20	221	262	0
2	Marine-vessel operation	1	16	13	3	16	0	0
3	Marine-vessel operation	1	392	362	30	391	1	0
2	Metal working	1	1	1	0	0	1	0
3	Metal working	11	93	86	7	7	86	0
2	Painted surfaces	2	37	34	3	10	27	0
3	Painted surfaces	4	6	6	0	2	4	0
2	Radar operations	1	1	1	0	0	1	0
3	Radar operations	1	5	5	0	5	0	0
2	Recycling-collections center	1	6	6	0	0	6	0
2	Rubber and plastics shop	1	3	3	0	0	3	0

BASE OPERATIONS								
RAC	**Operation**	**Installations**	**# Exposed**	**Male**	**Female**	**Military**	**Civilian**	**Contractor**
2	Sandblasting (outdoor)	3	21	21	0	0	21	0
3	Sandblasting (outdoor)	2	40	38	2	25	15	0
2	Silk screening	1	2	1	1	0	2	0
3	Silk screening	5	13	11	2	1	12	0
2	Stencil	2	31	28	3	3	28	0
3	Tire repair	2	4	4	0	2	2	0
2	Administrative operations	1	32	32	0	0	32	0
3	Administrative operations	1	1	1	0	0	1	0
3	Aerosol-can painting	4	162	159	3	71	91	0
1	Air conditioning	1	15	15	0	15	0	0
3	Air conditioning	8	96	96	0	6	90	0
3	Automatic nailing	1	5	5	0	0	5	0
3	Brush or roller application	5	66	65	1	4	62	0
3	Chiller plant operation	2	35	34	1	0	35	0
3	Electrical work	12	99	95	4	17	82	0
3	Fiberglass handling	1	7	7	0	7	0	0
3	Filling	2	6	6	0	4	2	0
3	Finish coating	1	2	1	1	0	2	0
3	Generator and heating plant	1	6	6	0	0	6	0
3	Gluing	3	49	46	3	3	46	0
3	Honing wood	1	2	2	0	0	2	0
3	Kilning	6	18	9	9	0	18	0
3	Laminating	1	2		1	0	2	0

BASE OPERATIONS								
RAC	**Operation**	**Installations**	**# Exposed**	**Male**	**Female**	**Military**	**Civilian**	**Contractor**
3	Leather cutting	1	3	3	0	0	3	0
3	Lithographics	2	7	7	0	0	7	0
3	Machine shaping and cutting	2	4	3	1	0	4	0
3	Mower operation	1	4	4	0	1	3	0
3	Office machine repair	1	10	10	0	0	10	0
3	Offset printing	1	16	15	1	0	16	0
3	Road and grounds maintenance	4	62	61	1	0	62	0
3	Sampling collection	2	13	11	2	6	7	0
3	Sewing and cutting fabrics	1	8	7	1	0	8	0
3	Spot removal	1	8	7	1	0	8	0
3	Spray cleaning	2	17	14	3	1	16	0
3	Steam-line repair	1	4	4	0	0	4	0
3	Stencil	4	60	58	2	4	60	0
3	Surface treating	1	1	0	1	0	1	0
3	Woodworking shop	2	26	25	1	0	26	0
RAC 1 Subtotals			18	18	0	0	18	0
RAC 2 Subtotals			353	325	25	61	287	5
RAC 3 Subtotals			2771	2577	194	1047	1723	1
Totals			3142	2923	219	1108	2028	6

HEALTH AND MEDICAL								
RAC	**Operation**	**Installations**	**# Exposed**	**Male**	**Female**	**Military**	**Civilian**	**Contractor**
2	Brush or roller application	1	8	5	3	8	0	0
2	Radiological analysis	1	2	2	0	0	2	0
3	Aerosol-can painting	1	3	3	0	2	1	0
3	Brush or roller application	1	18	18	0	13	5	0
3	Electrical-part repair	27	18	16	2	5	13	0
3	General dental care	2	3	2	1	1	2	0
3	General health care	2	6	5	1	4	2	0
3	Metal melting	1	5	3	2	1	4	0
3	Molten-metal pouring	2	10	9	1	1	9	0
3	Other	1	10	9	1	3	7	0
3	Radiological analysis	1	7	3	4	4	3	0
3	Sandblast cabinet	1	3	3	0	2	2	0
3	Surgery	1	2	1	1	0	2	0
3	Pneumatic-tool operation	1	13	13	0	3	10	0
RAC 1 Subtotals			0	0	0	0	0	0
RAC 2 Subtotals			10	7	3	8	2	0
RAC 3 Subtotals			98	85	13	39	59	0
Totals			108	92	16	47	61	0

Appendix M

Selected State Lead Programs and Regulations

States have initiated a variety of programs to control lead exposure. Several of these programs are described below. Installations may need to be aware of these programs. State points of contact are listed in Appendix J.

Alabama has established a State lead-abatement program which addresses monitoring BLLs in children and regulating lead in housing construction. An action level of 15 µg/dl of lead in the blood has been established for children according to CDC recommendations (Hanes, 1994). Alabama has adopted HUD guidelines for lead paint and wipe samples, and the State follows the OSHA standards for lead in housing construction (Grey, 1994).

Iowa's lead-abatement program addresses lead in public water supplies and occupational exposure to lead. Iowa has established an MCL for lead in drinking water at 0.1 ppb (Choquette, 1994). The Iowa Division of Labor Services has established an action level for employee exposure to airborne concentrations of lead of 30 $\mu g/m^3$ of air averaged over an 8-hour period. The Division of Labor Services has also established a PEL for lead, mandating that no employee shall be exposed to lead at concentrations greater than 50 $\mu g/m^3$ averaged over an 8-hour period (Slater, 1994).

Maine has established a State lead-abatement program that covers lead in public water supplies and lead monitoring in residential housing. The State standard for lead in drinking water is 0.015 mg/L (Breau, 1994). Maine has established an MCL of 2 milligrams per cubic centimeter (mg/cm^3) for lead dust in residential housing units (Jones, 1994). This State standard would apply to off-base military housing units in Maine; whereas, the Federal HUD standard of 1 mg/cm^2 would apply to on-base military housing units (Jones, 1994).

Massachusetts has a childhood lead-poisoning prevention program as well as a voluntary residential lead abatement program (Antonellio, 1994). The childhood lead- poisoning prevention program requires communities to sample school sites for lead contamination. The State has adopted the Federal standards for regulating lead in drinking water.

Nevada has adopted the Federal OSHA standards for occupational lead exposure. The State has not promulgated its own regulations regarding lead control (Going, 1994).

Pennsylvania's lead poisoning program regulates lead in public water supplies. The State has established an action level of 15 ppb for lead in drinking water (Erickson, 1994), and has established numeric cleanup levels for lead in soil of 200 milligrams per kilograms (mg/kg) for nonindustrial land, and 600 mg/kg for industrial land. These values are based exclusively on protecting human health to a BLL of 10 pg/dl (Final Lead Policy, 1994).

Texas has a childhood lead project requiring monitoring BLLs in children under age twelve (Sindow, 1994). Texas has adopted the Federal OSHA standards for occupational lead exposure (Sindow, 1994).

Vermont has a LBP-abatement program which requires certification of persons engaged in LBP removal activities (Crampton, 1994). Vermont regulations for lead control also specify appropriate methods to be used in the removal of lead paint, prohibiting open- abrasive blasting and dry sweeping of lead-contaminated areas or surfaces (Crampton, 1994). Disposal of wastes generated from LBP activities is regulated by the Vermont Agency of Natural Resources, Hazardous Waste Management Division, 802-241-3888. The State standard for lead in drinking water is 0.015 mg/L (Bartholomu, 1994).

Appendix N

Contacts for Additional Information on Lead Substitutes or Containment

Relevant Mission Area	Area of Expertise	Contact
Training and Readiness	Ammunition	Kristin Vogelsang, USARDEC, 204-724-6056 Joe Harvey, DOE, 301-903-6736 James Filgiola, Olin Corp., 202-331-7400 Larry Dickens, Martin Marietta Corp., 615-576-9682
Training and Readiness	Firing Ranges: Bullet Containment Systems	Alec Fletcher, Caswell International Corporation, 703-765-2953 Richard Hayes, Range Management Services, 708-639-0011
Training and Readiness-Base Operations	Lead-Acid Batteries	Jeff Miller, Lead Industries Association, 212-578-4750 David Rand, Advanced Lead-Acid Battery Consortium, 919-361-4647 Selwyn Hopkins, Independent Battery Manufacturers Association, 813-586-1408
Logistics-Base Operations	Paint for Steel: risk-reduction in removing LBP, including techniques, performance, and vendors.	Journal of Protective Coatings and Linings, published by: Steel Structures Painting Council 4516 Henry Street Pittsburgh, PA 15213 412-687-1113
Base Operations	Traffic Paint: Performance of lead-free yellow traffic paint for road surfaces.	Travis Brooks, Federal Highway Administration, 202-366-0411 Many states (Departments of Transportation) use lead-free paint, including the following: Virginia, 804-328-3120 (Tom Neal) Texas, 512-465-7469 (Art Barrow) Missouri, 314-751-2785 (Jim Jackson)

Relevant Mission Area	Area of Expertise	Contact
Logistics/ Industrial Operations	Radiator repair: workplace risk-reduction and material substitution	Wayne Juchno, National Automotive Radiator Service Association, 215-541-4500
Logistics/ Industrial Operations	Solder for radiator repair, plumbing, and electronics. Most vendors offer both lead and lead-free solder	Vendors include: Fusion Inc., 216-953-4964 High Performance Materials Inc., 314-935-4869 Taracorp Inc., 800-851-3300 Engelhard Corp., 800-225-2130 Additional lists of vendors possible by contacting: National Automotive Radiator Service Association, 215-541-4500 (for radiator solder) Institute for Interconnecting and Packaging Electronic Circuits, 708-677-2850 (for printed circuit boards)
Logistics	Ink	Supplier of lead-free printing inks: Alden & Ott, 708-956-6830

Appendix O

Soldier's Field Guide to Lead-Exposure Reduction

This field guide is intended to be a method of providing essential, summarized information for soldiers and Army civilian employees working and training under field conditions. It could be incorporated into unit or organizational field SOPs, unit maintenance and training SOPs, and reproduced and distributed to each individual. The field guide is not intended to replace existing industrial hygiene or occupational health requirements or guidance. Rather, it is intended to provide common sense guidance to those whose lead exposure is intermittent, infrequent, and may be under field conditions.

Soldier's Field Guide to Lead-Exposure Reduction

Lead is a highly toxic substance with many military uses. It can be used safely if you follow certain procedures. You can avoid being exposed to lead by using supplies and equipment properly and by practicing simple procedures. Lead can be inhaled or ingested; following these rules will eliminate or reduce greatly the possibility that you will be exposed to lead.

DO:

1. Practice good hygiene and field sanitation; wash hands and face whenever possible, to avoid hand-to-mouth transfer of lead.

2. Wash your face and hands and change clothing after firing at an indoor range.

3. Avoid inhaling smoke from range fires.

4. Wear gloves when cleaning or servicing lead-acid batteries, or when handling vehicle wheel weights.

5. Maintain batteries and clamps properly to eliminate the need to repair posts, which contain lead.

6. Protect lead-acid batteries from freezing or damage.

7. Dispose of lead-containing waste (batteries, expended brass, paint dust) properly and safely according to unit procedures.

8. Use PPE when welding, metal cutting, spray painting, paint stripping, or repairing equipment using solder.

9. Drink water only from approved sources.

10. Have your BLL checked by medical staff if you work routinely with lead.

DON'T:

1. Eat, drink, or smoke during weapons firing, weapons cleaning, or when servicing lead-acid batteries.

2. Use paint intended for use on vehicles, equipment, or ammunition on facilities.

3. Burn painted wood.

4. Inhale fumes from spray paint.

5. Collect expended brass in your hat or helmet.

6. Handle expended small arms bullets.

7. Melt bullets to obtain lead for hobby purposes.

8. Abandon, bury, or bum ammunition.

9. Heat rations in metal food cans soldered with lead.

10. Use automotive or electronic solder for any type of plumbing.

Leaders: You can get help from unit medical, safety, and maintenance personnel on ways to limit lead exposure to your soldiers. Enforcing unit procedures, maintaining standards of hygiene in the field, and following prescribed maintenance and training procedures will ensure that your soldiers are protected from lead exposure.